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UNIVERSITY OF CALIFORNIA

ECONOMIC FACTORS IN PICKING, ASSEMBLING AND GRADING SEVILLANO OLIVES

Gordon R. Sitton and L. L. Sammet

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FOREWORD

For the past several years, the olive industry has experienced increasing costs in the production, harvesting, and processing of olives. This period also has been one of relatively large crops and of declining prices for olives and olive products. In 1952, a large carry-over from the preceding season occurred, particularly in canned olives of certain sizes. The problem has many aspects. An important consideration is the possibility of reducing costs.

At the request of the industry, a study was undertaken of factors affecting the costs of harvesting and grading olives. The major parts of this study required field observations during the harvest season. Because of the short harvesting season, the field studies were made primarily in the Corning area, with limited coverage of olive plants in the Oroville area. Many of the results, however, should have fairly general application.

The growers and plant managers in the area covered by the study were unusually cooperative in connection with obtaining data for the study. In addition, Robert M. Hoffman, Arthur Shultis, and Delbert W. Williams, of the California Agricultural Extension Service, and Irving Dubov, George L. Viles, R. G. Bressler, and B. C. French of the Department of Agricultural Economics, California Agricultural Experiment Station, assisted in the collection and analysis of data.

This study was made cooperatively by the Agricultural Extension Service and the Giannini Foundation of Agricultural Economics of the University of California. The Bureau of Agricultural Economics, United States Department of Agriculture, assisted in certain technical phases of the work.

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Efficiency in Fruit Marketing

PICKING, ASSEMBLING, AND GRADING SEVILLANO OLIVES

Gordon R. Sitton and L. L. Sammet[1]

INTRODUCTION

Reports by growers for the 1952 season on the costs of harvesting Sevillano olives indicate a range from $54 to $82 per ton, with the average cost $62 per ton of fruit. Of the total harvesting cost, 83 per cent was for picking, and the remaining 17 per cent was for supervision and hauling. Compared with prices most frequently quoted in 1952, the average harvesting cost of $62 per ton exceeds the prices received by growers for olives of lower size and quality. The quantity of fruit in such subgrades made up as much as 19 per cent of the total harvest of some growers in the 1952 season and averaged 16 per cent for all growers. Returns from one-sixth of the grower's output, therefore, were less than the average cost of harvesting.[2]

Packers have been carrying an increasing inventory of canned olives in the face of higher processing costs and lower canned olive prices. These circumstances emphasize the importance of cost reduction for both grower and packer.

The Scope of This Report

At the request of the industry, a study of olive harvesting was made during the 1952 harvest season. Practices studied included picking, transporting, and grading the fruit. Data have been analyzed to determine possible ways of lowering costs and reducing losses from fruit deterioration and damage. This report is based on data collected from the following sources: (1) costs for picking and hauling obtained from growers' accounts in the Corning area of Tehama County;

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L. L. Sammet is a Cooperative Agent of the California Agricultural Experiment Station and the United States Department of Agriculture, Bureau of Agricultural Economics.

[2] These costs should not be considered as covering the entire Corning area but merely as representing those growers who reported harvesting costs. These costs give an indication, however, of the range and level of the costs involved.

(2) detailed study of picking operations in nine Sevillano groves in that area; (3) detailed studies of the operation of receiving and grading operations in eight olive plants in the Corning and Oroville areas; (4) tests to determine factors affecting the grade of the olive fruit and, specifically, the effect of various methods of handling and delay in handling between picking and grading; and (5) studies testing the possibility of using a sample grading technique rather than the present "break-for-lot" system of grading olives in the receiving plant.

The detailed studies on which this report is based have been limited to the Sevillano variety, but much of the information collected can be applied to other varieties as well.

Utilization of Olives in Recent Years

Unlike most fruits, the olive is not edible as it comes from the tree. Conversion to an edible food involves a number of processes which require from a few days to many months to complete.

Pickling for consumption as ripe or green olives is the principal outlet for California olives. Pressing for oil is the other important use. Table 1 shows estimated utilization for the years 1946-1951 for all olives grown in California. The tonnage canned more than doubled from 13,500 in 1948 to an all-time high of 33,300 in 1951.[3] This represents a shift toward canned olives as the major outlet since the previous high of 27,500 tons in these processes in 1946 was approximately double the annual amounts canned in the preceding five years. Tonnage crushed for oil exceeded tonnage canned in two of the six years, 1946-1951, as compared with twelve of the twenty-eight years, 1919-1946.

The ultimate utilization of the fruit is affected by variations inherent in the several varieties. Distribution of the 1951 crop among the several products is shown by variety in Table 2. The low tonnages--5 per cent and 4 per cent, respectively--of the Sevillano and Ascolanos used for oil reflect the low oil yield of these varieties and the relatively high prices paid for canning olives in 1951. The processing for other than canned and oil represents largely a diversion of the smaller sizes of these varieties which cannot be canned as ripe olives under the terms of the marketing order for California canned olives.

Olives are sorted according to size as defined by the number of olives per pound. The size names currently being used and the size categories established by the California Ripe Olive Standardization Act are as follows:

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[3] As used here, "canned" refers to "ripe" and "green-ripe" processed olives.

TABLE 1

Estimated Production, Utilization, and Average Returns to Growers for California Olives, 1946-1952

Crop year	Canned		Crushed for oil		Shipped fresh		Other uses		Total production
	Production	Average returns	Production	Average returns	Production	Average returns	Production	Average returns	
	tons	dollars	tons	dollars	tons	dollars	tons	dollars	tons
1946	27,500	450	14,300	216	100	402	5,900	403	48,000
1947	13,700	186	19,400	121	600	178	6,300	159	40,000
1948	13,500	224	33,600	118	700	174	10,200	128	58,000
1949	20,400	258	7,900	70	600	179	6,100	119	35,000
1950	24,900	305	9,700	106	200	220	7,200	140	42,000
1951	33,300	262	22,400	65	600	292	7,700	89	64,000
1952	--	149	--	67	--	--	--	--	57,000

a/ "Other uses" include olives used for California Spanish Green, Greek style, Sicilian style, chopped, brine cured, etc., and 200 tons for home use.

Source: U. S. Crop and Livestock Reporting Service, Annual Crop Reports.

TABLE 2

Estimated Olive Production, Utilization, and Returns to Growers, by Variety, 1951 Crop

Utilization	Manzanillo	Mission	Sevillano	Ascolano	Others	All varieties	
						Total	Average returns
	tons						dollars
Canned	15,870	7,020	8,400	1,570	440	33,300	262
Oil	3,790	17,740	640	70	160	22,400	65
Green	1,470	290	1,070	180	290	3,300	89
Greek	70	1,230	--	--	--	1,300	89
Sicilian	--	--	1,290	10	--	1,300	89
Other uses[a]	910	670	20	30	170	1,800	89
Shipped fresh	60	110	60	--	370	600	292
All uses	22,170	27,060	11,480	1,860	1,430	64,000	173

a/ Other uses include olives used for Sicilian style, chopped, brine cured, etc., and 200 tons for home use.

Source: U. S. Crop and Livestock Reporting Service, final figures for the 1951 olive crop.

"Small," "select," or "standard (s)"—averaging 135 to the pound.

"Medium"—averaging 113 to the pound.

"Large"--averaging 98 to the pound.

"Extra large"—averaging 82 to the pound.

"Mammoth"--averaging 70 to the pound.

> With a tolerance above or below of 7½ per cent by count, except that "small," "select," or "standard(s)" shall not count less than an average of 128 or more than an average of 140 to the pound.

"Giant"--averaging 53 to 60 to the pound, with no tolerance.

"Jumbo"--averaging 46 to 50 to the pound, with no tolerance.

"Colossal"--averaging 36 to 40 to the pound, with no tolerance.

"Supercolossal"--not to exceed 32 to the pound, with no tolerance.

> In determining such count, the samples shall be weighed so as to determine the weight thereof by pounds, ounces, and fractions of an ounce.

Sevillano is the commercial variety giving the highest percentage of the heavier sizes. Typically 80 per cent or more of this variety grades in the four sizes, supercolossal through giant, with colossal or jumbo the modal size. Sizes which can be marketed as canned ripe olives are regulated pursuant to the provisions of the California Marketing Act of 1937. Requirements established for the 1952-53 marketing season prohibited the canning of whole or pitted Sevillano olives smaller than the grade of giant.

Utilization of the olive may be affected by the physical condition of the fruit as well as variety and size. Fruit that is too mature to withstand the processing for ripe olives is sorted out and crushed for oil or specially processed for use as "by-products" under such names as "Italian" or "French style" pickles. Fruit that has been bruised, cut, or otherwise damaged while on the tree or in picking and handling is culled out and crushed for oil or discarded.

Processes in Producing Pickled Olives

Pickled olive production involves a continuous production process that can be broken down into the following substages: (1) growing the fruit; (2) picking; (3) transporting from orchard to processing plant; (4) grading and sorting; (5) processing; and (6) canning.

Although any one of these is affected by all of the others, this study will deal only with picking through grading and sorting. It is recognized that some cultural practices involved in growing the fruit may have a very important bearing on harvesting due to condition of the orchard and condition of the fruit at

picking time, but sufficient information is not available from this study to permit analytic treatment of this point. Processing and canning are not a part of harvesting and will be mentioned only insofar as handling in the previous stages needs to be directly related to processing problems.

Since curing is not to be discussed at length, the changes in the olives which will be covered in this report deal with the assembling of the fruit at the plant and its sorting into size and quality grades in preparation for processing. Growers deliver orchard-run fruit to these assembly points where it is sorted for size and quality, and they are paid on the basis of fruit that has been graded but not otherwise changed in nature. Packers accept the ungraded fruit, grade it, and buy sized and culled but otherwise unprocessed fruit.

FACTORS AFFECTING THE GRADE OF OLIVES

Olives received at packing or grading plants are sorted according to size and condition of the fruit. As stated above, olives are graded for size into three specific categories: (1) the canning sizes of supercolossal through giant; (2) the sizes from mammoth down through medium or, in some cases, standard which, although they cannot be processed as canned green ripe or black ripe olives, may be made into green olives; and (3) those sizes that are below standard and are included in the culls. The breaking point between sizes saved for processing as other than ripe olives and the cull sizes depends upon the prices being paid and the outlets available for olives of these types.

As well as being graded for size, the olives are divided according to quality, i.e., damaged olives are hand sorted from olives that are to be processed for pickles. In some cases the hand culling is done prior to sizing and, therefore, culls are picked from all the olives received. In other cases, hand culling is done after the olives have been sized, and in this case culls are being picked only from the canning size olives.

Observation of culling and analysis of culls show that olives that are discarded as culls can be divided into several categories: first, those that have been damaged during the growing period by bird pecks, bruises caused from rubbing against branches, or a condition known as split pit in which the olive is slightly misshapen and the pit splits when the olive is eaten; second, damage to the fruit during the picking and handling process, such as bruising, cutting, or scratching. If the scratch or indentation on an olive is so severe that the outer skin is broken, the fruit is discarded as a cull because it would break down in the curing process. The total amount of this type of damage is subject

[illegible]

of processing and will be mentioned only insofar as handling in the previous stages seems to be directly related to processing problems.

Since curing is not to be discussed at length, the changes in the olives which will be covered in this report deal with the assembling of the fruit at the plant and its sorting into size and quality grades in preparation for processing. Growers deliver orchard-run fruit to these assembly points where it is sorted for size and quality, and they are paid on the basis of fruit that was thus graded but not otherwise changed in nature. Packers accept the ungraded fruit, grade it, and put sized and culled but otherwise unprocessed fruit.

[illegible]

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A third condition which causes olives to be culled is overripeness or overmaturity. This varies with the time of the season. Early in the season, some olives which have become mature enough to have a red or purple color over the entire olive are permitted to pass for pickling unless the colored area actually shows some shriveling and softening of tissue. Later in the season, however, this type of fruit is culled much more heavily because it is more likely to break down in the brine.

The percentage of given lots judged cull at the time of grading and sorting observed at Corning in 1952 varied from less than 1 per cent to 9.75 per cent. Percentage of culls was lower in the Corning area than in some of the other areas because of the absence of scale damaged fruit.

The proportion going into culls varied between orchards and between lots of fruit from any given orchard. There was a noticeable difference in the content of the culls in lots with different size distributions. The average percentage of culls in those lots with a peak size class of giants was 1.9 per cent as compared with 6.2 per cent culls in the lots which had a peak size class of supercolossal.

The culls selected from the lots with a predominance of giants had higher percentages of size culls and very few, if any, culls because of overripeness, whereas those culls selected from the lots which had a predominance of supercolossal size were primarily culls because of overmaturity, the second cause being damaged fruit. This change in the range of size distribution is emphasized in Table 3 by comparing not only the average percentage of culls from lots with different size distributions but also the average per cent of noncanning fruit for both size and quality reasons. The lots with a peak size of giant had an average of 27.7 per cent noncanning fruit. The per cent of noncanning fruit decreased as the peak of the size distributions moved toward the larger size grades. Lots with a peak of supercolossals had an average of only 8.9 per cent noncanning fruit.

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TABLE 3

Relationship Between Size Distribution and Percentage of Culls in 62 Lots of Olives Received at Plants During the 1952 Season

Peak size class	Average, culls	Average, noncanning
	per cent	
Giant	1.9	27.7
Jumbo	2.1	16.6
Colossal	4.5	9.4
Supercolossal	6.2	8.9

Picking Time in Relation to Condition of Fruit

Observation of Sevillano olives in the Corning area indicates that maturity and size are the two most important considerations in appraising the condition of the fruit on the tree. Normally there is a wide variation in the fruit hanging on any one tree at harvest time. As discussed above, the fruit may vary in size from supercolossal down to one of the very small sizes and in maturity may range from olives that are too mature for processing as pickles to fruit that is considered extremely green and has shown very little signs of approaching maturity.

Individual lots of fruit delivered to one plant in Corning during October, 1952, had a percentage of supercolossal fruit ranging from a high of 39 per cent to a low of less than 1 per cent of the total weight of the lot. For these two lots, the size distributions were as follows:

Size	Per cent	
Supercolossal	39	--
Colossal	36	5
Jumbo	11	23
Giant	4	37
Mammoth	2	23
Extra large	1	8
Other and culls	7	4
Total	100	100

Some of these extreme differences which are found in individual lots of fruit tend to balance out when one considers total deliveries for the season from a particular grower. Table 4 presents data showing the percentage size distribution of total deliveries of ten growers during the 1952 season; in these there is a range from 24.5 per cent supercolossal to 3.67 per cent supercolossal with an average for the ten growers of 13.64 per cent. Approximately one-third of the olives delivered by all of these growers was sized as colossal with less than 6 per cent going into culls for reasons of either size or quality.

Only 13 per cent of the total fruit delivered by these growers was graded into other than canning sizes as defined above. Individual lots delivered to this same plant showed a high of 34.9 per cent noncanning olives for one lot and a low of 5.04 per cent noncanning olives for another lot.

TABLE 4

Size Distribution of Season's Production Delivered
to a Processing Plant by Ten Typical Sevillano Growers in 1952

	Distribution of sizes							
Grower number	Super-colossal	Colossal	Jumbo	Giant	Mammoth	Extra large	Culls	Total
	per cent							pounds
1	7.77	29.02	34.37	23.16	2.54	0.65	2.49	28,591
2	8.53	28.17	29.10	18.33	7.84	3.50	4.53	23,687
3	10.48	27.37	25.51	17.54	7.51	3.03	8.56	57,558
4	6.80	26.90	30.98	20.05	8.54	3.22	3.51	74,406
5	13.78	35.36	25.43	11.40	4.27	2.21	7.55	159,828
6	24.52	39.09	18.42	7.32	2.73	1.02	6.90	152,794
7	6.60	24.50	31.20	22.79	8.33	3.01	3.57	32,354
8	3.67	21.01	30.85	27.18	10.93	3.98	2.38	59,333
9	12.35	34.04	27.19	15.16	6.10	2.25	2.91	25,270
10	18.70	39.64	22.63	9.61	3.96	1.70	3.76	29,249
All growers	13.64	32.28	25.68	14.85	5.62	2.28	5.65	643,070

[illegible]

distribution of total deliveries of ten growers during the 1952 season; in them there is a range from 24.5 per cent supercolossal to 3.6 per cent colossal with an average for the ten growers of 13.6 per cent. Approximately one-third of the olives delivered by all of these growers was sized as colossal with less than 5 per cent going into culls for reasons of either size or quality.

Only 13 per cent of the total fruit delivered by these growers was graded into other than canning sizes as defined above. Individual lots delivered to this same plant showed a high of 31.9 per cent supercolossal olives for one lot and a low of 5.04 per cent [illegible] olives for another lot.

Size of Fruit in Relation to Maturity

The grower can influence to some extent the size distribution of his fruit by attempting to gain the maximum increase in size prior to picking.

Studies at Davis have shown that growth of the olive fruit exhibits a cyclic pattern. An early period of rapid growth is followed in August and September by a period of slower growth. A final period of accelerated increase in size and weight of fruit takes place within a ten-to-fourteen-day period immediately before the fruit starts to color. Figure 1 presents the results of Hartmann's tests with the Mission variety at Davis during the 1947 growing season. The accelerated period of growth during that season occurred from early to mid-October as shown.[4]

The percentage increase in size measured at two-week intervals from early October for the three years, 1946-1948, is shown in Table 5.

TABLE 5

Rate of Olive Growth During Selected Periods

Date of measurement	1946 Manzanillo	1947 Mission	1948 Ascolano	1948 Manzanillo	1948 Mission
	per cent				
October 2-5	100.0	100.0	100.0	100.0	100.0
October 17-19	117.2	132.6	128.4	123.4	125.7
October 30-November 2	127.6	148.8	127.5	141.0	134.1
November 15-18	127.6	137.6	140.0	131.8	149.1

Source: Computed from data presented in Hartmann, H. T. "Growth of the Olive Fruit." Proceedings of the American Society for Horticultural Science, vol. 54, 1949. pp. 86-94.

Some of the variation in size may have been due to sampling error; however, the over-all increases appear to be significant.

Data are not available to show the precise relationship between weather conditions and rate of growth in fruit. However, comparison of the data presented by Hartmann with daily rainfall data for the years 1946-1948 shows that

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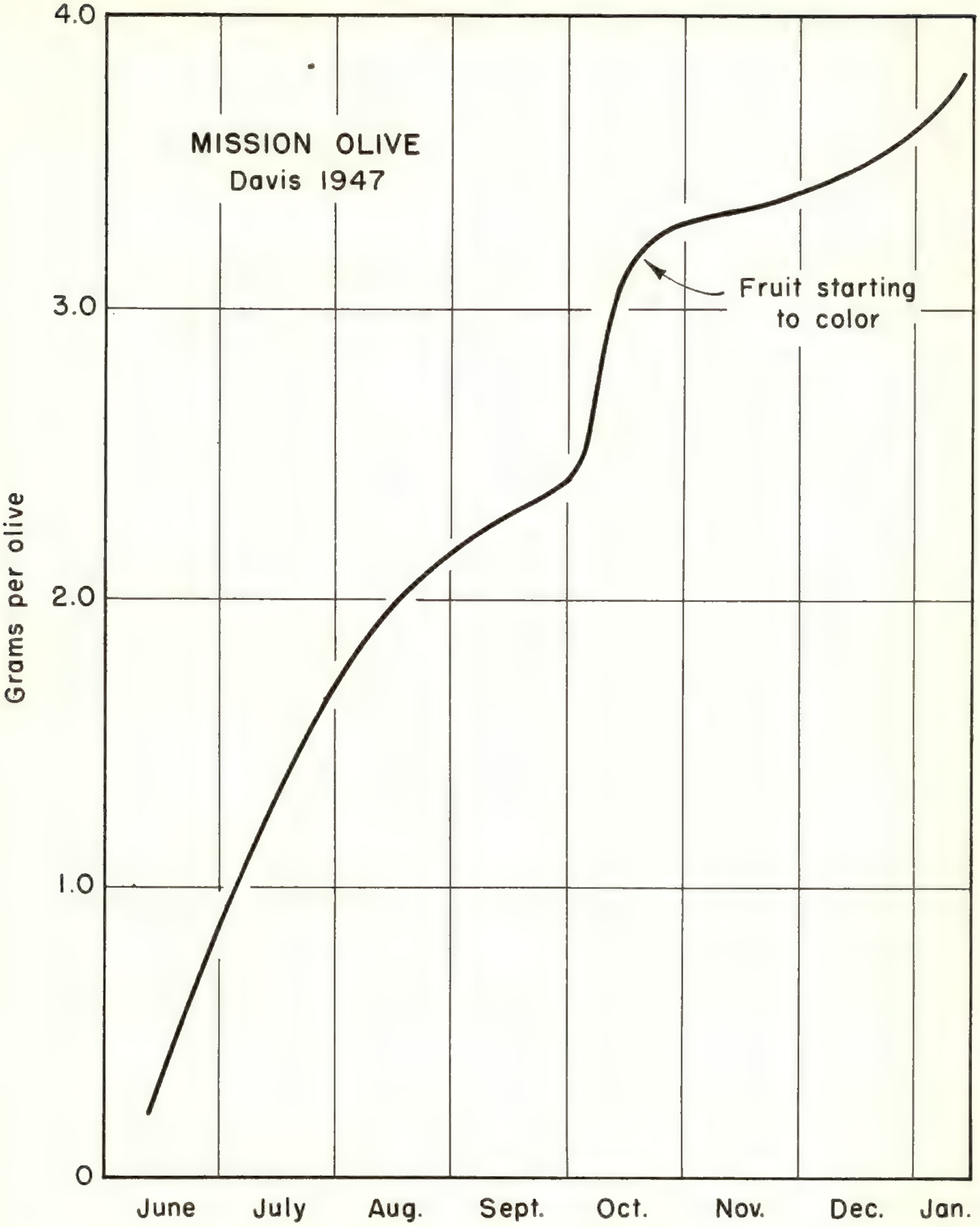
[4] Hartmann, H. T. Olive Production in California. 1953. p. 28 (Calif. Agr. Exp. Sta. Manual 7)



Source: Hartmann, H.T. Olive Production in California, Manual 7, Cal. Agr. Exp't. Sta.—Ext. Serv., 1953, p. 28

FIGURE 1. GROWTH OF OLIVE FRUIT, MEASURED IN FRESH WEIGHT.

in every case the period of rapid growth occurred during a two-week period in which there was significant rainfall. These data indicate that there is merit in the idea expressed by many olive growers and packers that a rapid increase in the size of olive fruit occurs following a rain. Unfortunately, the 1952 season did not provide sufficient rainfall to permit actual measurement of this increase in size in the field as part of this study. Many growers noted that they failed to see the usual rapid swell in size of the fruit which they normally have at harvest time.

Data summarized in Table 5 show an increase in weight of from 27 to 49 per cent during the period, early October to mid-November. This is the period which normally covers the range of picking dates in the Corning area.

The wide range in available data and the possibility that weather conditions might cause a smaller increase than shown in Table 5 make it difficult to estimate the gain in tonnage from delayed picking, but observations made in 1952 indicate that in some cases growers are failing to achieve yields commensurate with their cultural practices because they are picking too soon.

The increase in value of olives harvested late in the season would come from two sources: the gain in weight and the increased average size. For example, a ton of olives with an average count per pound of 50 olives would be worth $150 at the prices most commonly quoted at Corning in 1952.[5] If we assumed a 25-per cent increase in weight, these same olives would weigh 2,500 pounds. Their value would be more than $150 per ton, however, because with their increase in weight the 100,000 olives (50 x 2,000) would average 40 to the pound for an average value per ton of $200. The same olives which were worth $150 would thus be worth $250--2,500 pounds at $200 per ton--a gain of 67 per cent. Note that the increased value results almost equally from weight and size gains.

This increase in value is based on the relative prices prevailing in one year only and on a hypothetical increase in weight. Both the price changes between olives of different sizes and the amount of increase in weight might be more or less in any given year, and weight changes would vary among orchards

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[5] Prices per ton used here and elsewhere in this report to arrive at values are as follows: supercolossal, $300; colossal, $200; jumbo, $150; giant, $125; mammoth, $50; extra large, $30; large, $20; medium, small, and cull, $10. These were prices paid to growers in the Corning area by some buyers in 1952. Their use here does not imply that they are normal either as to relative prices among grades or as to absolute level of prices during 1952 or in other years.

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The wide range in available data and the possibility that weather conditions might cause a smaller increase than shown in Table 5 make it difficult to estimate the gain in tonnage from delayed picking. But observations made in 1952 indicate that in some cases growers are failing to [illegible] with their cultural practices because they are picking too soon.

The increase in value of olives harvested late in the season would come from two sources: the gain in weight and the increased average size. For example, a ton of olives with an average count per pound of 50 olives would be worth $150 at the prices most commonly quoted at Corning in 1952.[1] If we assumed a 25-per cent increase in weight, these same olives would weigh 2,500 pounds. Their value would be more than $150 per ton, however, because with their increase in weight the 100,000 olives (50 x 2,000) would average 40 to the pound for an average value per ton of $200. The same olives which were worth $150 would thus be worth $250—2,500 pounds at $200 per ton—a gain of 67 per cent. Note that the increased value results almost equally from weight and size gains.

This increase in value is based on the relative prices prevailing in one year only and on a hypothetical increase in weight. Both the price changes between olives of different sizes and the amount of increase in weight might be more or less in any given year, and weight changes would vary among orchards [illegible] in the same year. The magnitude of this gross change in value, however, is great enough to encourage growers to consider delayed picking until the bulk of the fruit in an orchard has made the increase in growth just prior to maturity. This stage is usually accompanied by the smoothing of the skin and the change from green to straw color.

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[1] Prices per ton used here and elsewhere in this report [illegible] are as follows: super-colossal, $[illegible]; colossal, $200; jumbo, $[illegible] [illegible]

Available data indicate that the rapid increase in growth levels off abruptly after the fruit starts to color. Picking as soon as the rapid increase in size is completed would give the benefit of increased growth and minimize the risk of loss from later unfavorable weather.

The delay of picking to achieve maximum growth should give an increase in gross returns, but the increase in net returns may be less because of increased costs and risks. If growth is to continue, further irrigation will be necessary in most years, and there may be some increase in picking costs as the season progresses. Picking labor may be difficult to obtain. In addition, there are increased risks from early frost and from continuous rain.

The grower who delays harvesting in order to obtain larger size fruit can expect to have a reduction in the percentage of noncanning fruit but also may have an increase in the percentage of fruit which will grade cull because of overmaturity. A loss in value because of increase in culls would be more than offset by the total increase in weight, by the movement of more fruit into the canning sizes, and by the movement upward in sizes by the canning fruit.

Time of Picking in Relation to Temperature

Weather risks may discourage some growers from delaying harvest. Olives may be damaged by freezing and become unsalable for processing as table olives or low temperatures and drying winds may cause shriveling and loss of weight.

Results of freeze injury studies recently published by Hartmann and Van Hook indicate that the freezing point of olives is between 24°-29° F. but that in some cases fruit was cooled to considerably lower temperatures with no injury resulting. Differences in effects of wind movement, presence of outside moisture on the fruit, maturity, and heat radiation from exposed fruit make it difficult to state a single temperature below which freeze injury is certain to occur.6/ However, it seems unlikely that freeze injury would occur when recorded temperatures are above 32° F. even though temperature of the fruit might be lower than this temperature as recorded by a weather thermometer in a protective shelter.

6/ Hartmann, H. T., and David Van Hook. "Olive Freeze Injuries." California Agriculture, vol. 6, no. 10, October, 1952.

[illegible]

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[illegible]

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Results of freeze injury studies recently published by Hartmann and [illegible] indicate that the freezing point of olives is between 26°–29° F. but that in some cases fruit was cooled to considerably lower temperatures with no injury resulting. Differences in maturity of wind movement, presence of outside [illegible] the fruit, maturity, and heat radiation from exposed fruit make it difficult to state a single temperature below which freeze injury is certain to occur.[illegible] However, it seems unlikely that freeze injury would occur when recorded temperatures [illegible]

[illegible]

A long series of daily temperature recordings is not available for Corning, but such data are available for Red Bluff, a few miles distant. During the period 1899-1952, the earliest date of recorded temperature of 32° was on October 29, 1946. October 30, 1935, was the only other date in this 53-year period on which the first killing frost in the fall occurred prior to November 1. Frequencies of years in which temperatures of 32° or below occurred relative to specific dates were as follows:

Before November 5	2 years
Before November 10	6 years
Before November 15	10 years
Before November 20	13 years
Before November 25	21 years
Before December 1	25 years
After December 1	28 years

These data show that based on the past 53 years one would not expect a damaging frost to occur before November 5 in more than 1 out of 26 years nor prior to November 15 in more than 1 out of 5 years. After November 20, the danger of a damaging frost increases sharply.

In most years, there is a likelihood that the latest practical date for picking Sevillano olives will have been reached prior to a killing frost because of the shriveling and weight loss which occurs in cool dry weather. In two of the three years studied by Hartmann as shown in Table 5, there was a slowing of growth or actual decrease in weight during the first half of November.

Size of Fruit in Relation to Size of Crop

The timing of picking in relationship to size and maturity of fruit is greatly affected by the weight of the crop. Trees with a light crop tend to mature the fruit earlier than trees with a heavy crop. Observation of individual trees in an orchard sometimes shows that the larger olives on a light producing tree are overmature by the time the rest of the orchard is considered ready for picking.

Comparison of total yield figures from orchards with heavy and light crops of fruit shows the earlier sizing in those with a light crop, which is sufficient to warrant their being picked earlier than would be indicated by the time of sizing data presented above. For example, fruit from an orchard of mature trees yielding a total of less than one ton per acre graded over 90 per cent in the top three sizes even though picked between October 14 and 16, 1952, while some heavy yielding orchards picked at the same time graded less than 40 per cent in these sizes.

[illegible] 29, 1945. October 30, 1935, was the only other date in this 53-year [illegible]

[illegible]	2 years
[illegible]	5 years
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

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[illegible] picking.

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Changing Price Relationships

One other major qualification of the advantages of delayed picking must be considered. If through delayed harvesting, or any other practice by a number of growers, the relative distribution of sizes was altered, then a change in relative prices would probably follow. Increased tonnage of the larger sized fruit might cause a reduction in the spread of prices between the several size grades in later years. This would reduce the advantage of the practices for the industry as a whole. The amount of the net gain to individual producers would depend on individual costs of production and yields. Any practice which involves merely altering the timing of operations--such as picking--and thereby increasing the yield without an increase in fixed costs would reduce fixed costs per ton of fruit.

The time of picking may be affected by outside factors which will not permit a grower to delay picking, such as method of financing or sale. Attempts to demonstrate the effects of timing of picking on yield in actual orchard trials in Tehama County in 1952 were abandoned in two orchards when sales contracts did not permit delayed picking of portions of the orchard.

Field Tests Relative to Time of Picking

One orchard was divided into three parts for picking. Some rows were left for picking late in the season, some were picked in midseason, and others were divided between midseason and late season with approximately one-fourth of the fruit removed in a first picking and the balance in a second picking.

In the first of the double picking, pickers were instructed to pick only giant or larger sizes. They were successful in this, for approximately 95 per cent of the fruit picked was in these sizes even though there was a heavy set of smaller fruit on the trees.

The fruit left on the tree failed to increase in size enough to make double picking a successful practice in this orchard in 1952. Total yield for the two pickings measured in pounds per tree was 35 pounds less than on the trees picked only once. Average value per ton was also lower on the double picked trees in spite of the fact that fruit in the first picking was more valuable. Increased growth of the larger fruit permitted to grow longer on the single picked trees more than offset the effect of reduced competition for the smaller fruit left on the double picked trees.

The fruit in the second half of the double picking and the late single picking which was picked during the second week of November appeared to be shriveled and spongy, indicating that it may have fallen from its maximum weight as did the fruit in some of Hartmann's studies.

[illegible]

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Changes in Condition of Fruit after Picking

After the fruit is picked, it continues to respire. In this process oxygen is taken in, the tissue is altered, and certain products of decomposition are given off, primarily heat, moisture, and carbon dioxide. In addition, there is some direct moisture loss by transpiration through the surface of the fruit. Respiration is accelerated at high temperature, and drying is more rapid at low relative humidity. Initially, these processes result in an increase in maturity, but eventually--through loss of moisture and decomposition of the plant tissue--the fruit loses weight, shrivels, and finally decays. If the grading and processing of fruit removed from the tree are delayed, these natural developments cause an increase in culls due to continued ripening of mature fruit and a loss in grade and tonnage as the result of shriveling.

After picking, olives may remain in the orchard for several hours before movement into a grading plant where they are stored on a dock on the outside of the building or inside the warehouse or shed until the time of grading. During the 1952 season, the elapsed time from picking to grading, observed in the Corning area, varied from a few hours to as much as 48 hours.

Field Tests of Shrinkage in Weight

Test Procedures

Tests were made to determine the amount and type of loss sustained under conditions of storage in the orchard and storage at the receiving plants for periods varying from one to seven days. Lots of freshly picked fruit were hauled to the plants, graded, weighed, and divided into two portions of twenty boxes each. One of these portions was taken back to the orchard and the other was stored in the plant. Fruit stored in the orchard was placed under trees in stacks three to five boxes high which approximated the conditions under which picked fruit would sit in the orchards until moved to the receiving plant. Fruit stored in the plants for testing was also in boxes and in all cases was inside the plant. Fruit was weighed daily until both lots were rerun over the plant grader at the end of the period.

During the period studied, average daily temperatures both inside and outside the plant were approximately the same. Temperatures in the plant, however, ranged from 55°-70° F. during the 24-hour periods while temperatures in the orchard ranged from slightly above 30° to over 90° on some exceedingly hot days. During the period, 8:00 A.M. to 5:00 P.M., temperatures in the

orchards were above temperatures in the plant. During these periods of high temperatures, the relative humidity in the orchard was much lower than that recorded within the plant. Added to these conditions of higher temperature and lower relative humidity, the strong, dry, north winds sweeping through the area during part of the harvest season caused further loss in weight of olives which were exposed to it.

Weight Loss

Under these conditions the weight loss observed was considerably greater in the orchard than in the plant. Figure 2 shows the weight loss experienced in orchard and plant storage under the conditions existing in the 1952 olive harvesting season. Olives left in the orchard for three days after picking lost approximately $1\frac{1}{2}$ per cent more of their original weight than olives of the same lot moved into the plant immediately after picking. This percentage difference increased as olives were left in the orchard for longer periods. This difference between orchard and plant storage prior to grading would not be expected to be as great if the olives at the plant were stored outside where they would be subject to higher temperatures.

The test lots of fruit were graded at the beginning of the tests, and daily weighings were by size grade. Sizes of colossal through mammoth were used. On the basis of five separate tests, there were no significant differences observed in the percentage weight losses in different sizes of olives.

Grade Loss Accompanying Weight Loss

Analysis of olive growth and value of individual lots discussed above showed that, in addition to the increase in weight, the increase in size contributed an important part of the increase in value. Following picking, this process is reversed, and as olives decrease in weight, they also decrease in size which results in an increase in the average count per pound and a decrease in average value.

Figure 3 shows the change in size distribution of a lot of olives which was graded shortly after picking, 20 hours after the first grading and 66 hours after the first grading. There was a decrease in the percentage of olives in the supercolossal, colossal, and jumbo grades and an increase in the percentage in the smaller size grades and in the olives graded cull. Applying the prices which have been used throughout this report as those typical of the Corning area in 1952 to these physical changes gives a decrease in value per ton from $142.50 at orchards were above temperatures in the plant. During the [illegible] of high [illegible]atures, the relative humidity in the orchard was much lower than that [illegible] during part of the harvest season caused further loss in weight of olives which were exposed to it.

[illegible]

Under these conditions the weight loss observed was considerably greater in the orchard than in the plant. Figure 2 shows the weight loss experienced in orchard and plant storage under the conditions existing in the 1952 olive harvesting season. Olives left in the orchard for three days after picking lost approximately 1½ per cent more of their original weight than olives of a same lot moved into the plant immediately after picking. This percentage difference increased as olives were left in the orchard for longer periods. This difference between orchard and plant storage prior to grading would not be expected to be as great if the olives at the plant were stored outside where they would be subject to higher temperatures.

The test lots of fruit were graded at the beginning of the tests, and daily weighings were by size grade. Sizes of colossal through mammoth were used. On the basis of five separate tests, there were no significant differences observed in the percentage weight losses in different sizes of olives.

[illegible]

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Figure 3 shows the change in size distribution of a lot of olives which was graded shortly after picking, 20 hours after the first grading and [illegible] hours after the first grading. There was a decrease in the percentage of olives in the supercolossal, colossal, and jumbo grades and an increase in the percentage in the smaller size grades when the olives graded out. Applying the prices which have been used throughout this report as those typical of the Corning area in [illegible] to these physical changes gives a decrease in value per ton from $112.[illegible] at

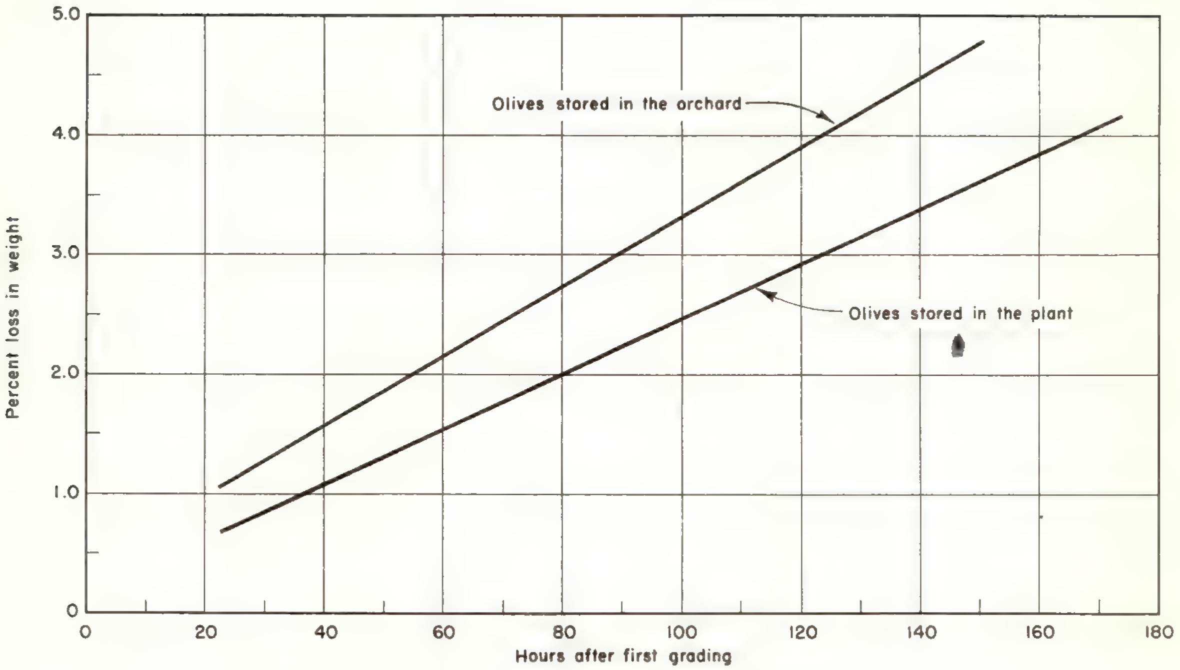

FIGURE 2. WEIGHT LOSS OF OLIVES STORED IN THE ORCHARD AND IN THE PLANT PRIOR TO GRADING.

the time of original grading to $137.30, 20 hours later, and to $130.60, 66 hours after the original grading. This particular test was run during the period, November 5 to November 8, 1952; the olives were mostly straw colored and, after the lapse of 66 hours, shriveling could be detected by feel.

Change in grade and value was considerably more pronounced than in tests run two weeks earlier when olives were less mature. In these earlier tests, the average loss in value per ton for five lots held from 15 to 20 hours was $1.55. It would appear from this that olives are better able to withstand a period of storage prior to grading when they are less mature.

Further demonstration of the physical changes in grades and changes in value is shown in Figure 4. Data for the first grading were obtained within a few hours after picking and show the percentage within each size grade of a lot of olives made up of five boxes in each of the four grades, colossal through mammoth. At the end of a storage period--165 hours for test I and 90 hours for test II--the lots were again run over the grader and the percentages shown in the regrade column for each lot represent the new grades obtained. The loss in weight during storage, ranging from 4 to 9 per cent of the original weight, is represented by the dotted portion of the regrade columns.

Principal changes observed were a marked decrease in the percentage of olives grading colossal and a less marked decrease, or in some cases an actual increase, in the percentage in the middle size grades as the larger olives moved downward into the smaller sizes. Some of the olives which had originally graded mammoth regraded extra large. The movement of fruit into culls varied from a low of 3.9 per cent for one lot held in a plant to a high of 6.9 per cent for a lot in an orchard. All of these culls came from the colossal, jumbo, and giant grades because the olives grading mammoth were not culled for quality. In every case the change in grade was of a nature to cause a greater loss in value of olives stored at the orchard than of olives stored in the plant, even though in one case the loss in weight was actually greater in the plant than in the orchard.

Analysis of Culls

Advanced maturity and the deterioration of scratches, bruises, and other damage during the period when the fruit was standing were the causes of discarding fruit as culls at the second grading. Since all of this fruit was culled for quality at the time of original grading, it follows that fruit culled at the end of the shrinkage period was that which had been passed at the first grading as suitable in quality for processing. The increase in maturity to a stage unfit the time of original grading, to $17.40, 24 hours later, and to $15.65, 96 hours after the original grading. This particular test was run during the period, November 5 to November 8, 1932; the olives were mostly straw colored and, after the lapse of 96 hours, shriveling could be detected by feel.

Change in grade and value was considerably more pronounced than in tests run two weeks earlier when olives were less mature. In these earlier tests, the average loss in value per ton for five lots held from 15 to 20 hours was $1.55. It would appear from this that olives are better able to withstand a period of storage prior to grading when they are less mature.

Further demonstration of the physical changes in grades and decrease in value is shown in Figure 4. Data for the first grading were obtained within a few hours after picking and show the percentage within each size grade of a lot of olives made up of five boxes in each of the four grades, colossal through mammoth. At the end of a storage period--16½ hours for test I and 90 hours for test II--the lots were again run over the grader and the percentages shown in the regrade column for each lot represent the new grades obtained. The loss in weight during storage, ranging from 4 to 9 per cent of the original weight, is represented by the dotted portion of the regrade column.

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Advance of [illegible]

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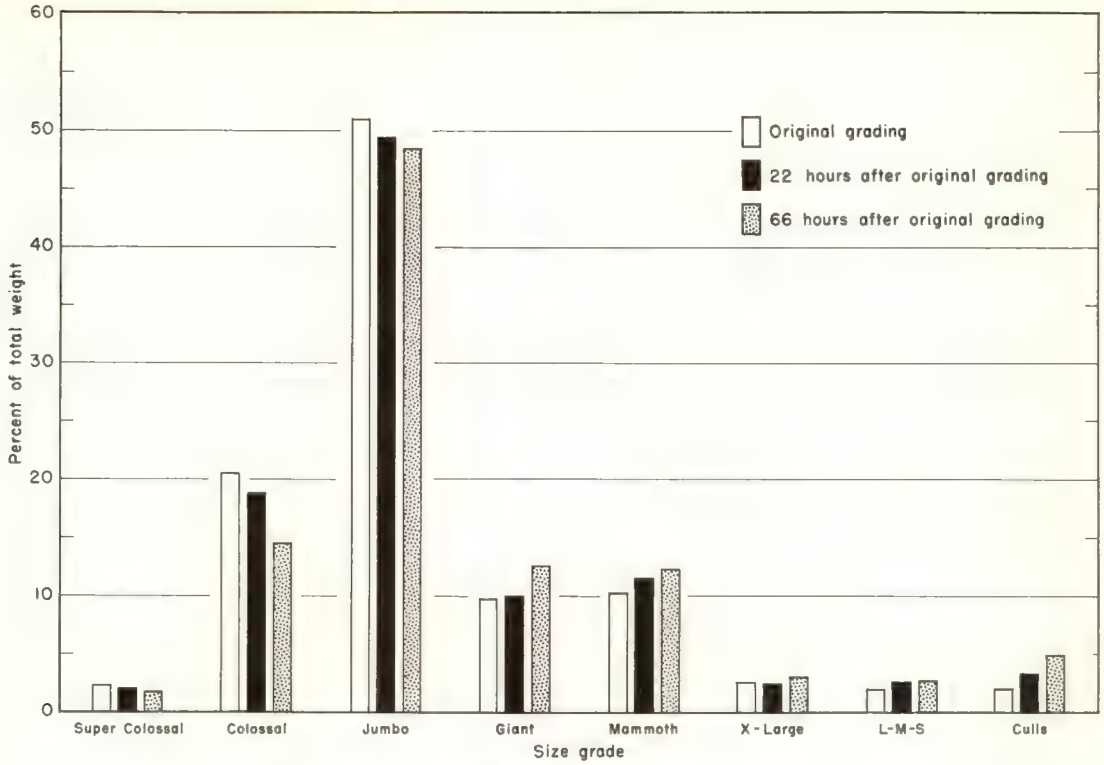

FIGURE 3. CHANGES IN SIZE DISTRIBUTION WITH LAPSE IN TIME BETWEEN PICKING AND GRADING.

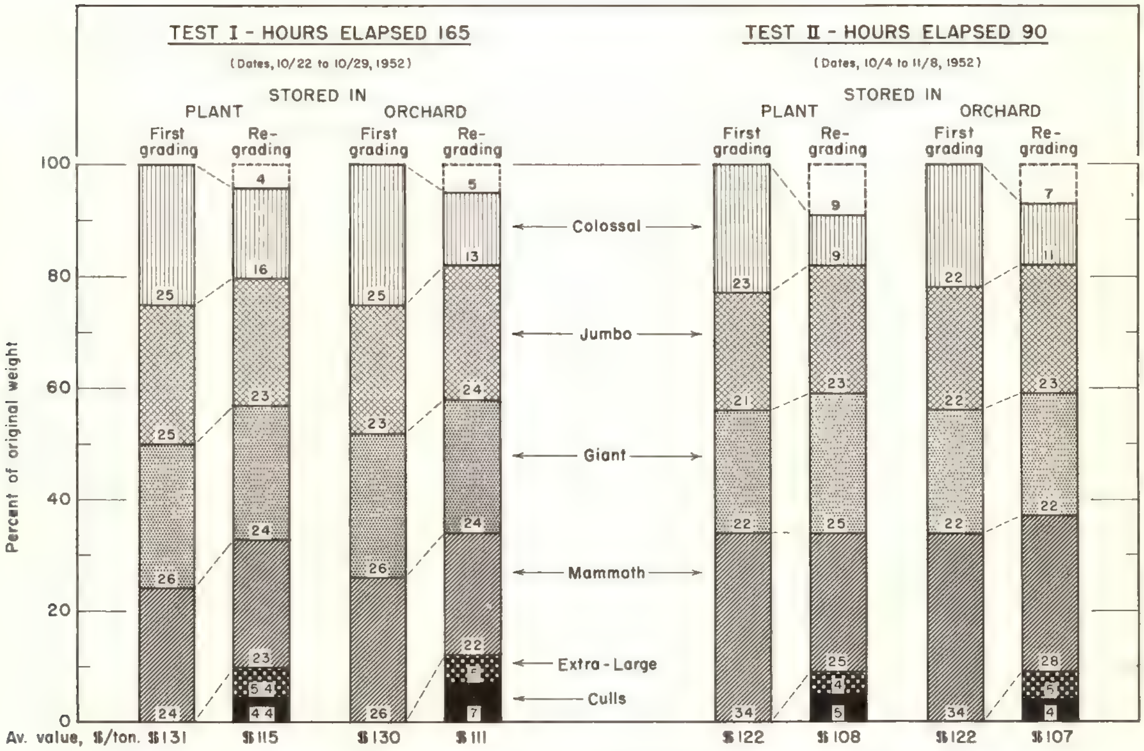

FIGURE 4. DECREASES IN WEIGHT, GRADE, AND VALUE OF SEVILLANO OLIVES BETWEEN TWO DATES OF GRADING.

for processing and the more evident, if not more severe, damage developed as a result of normal or expected deterioration during the waiting period. There is a possibility that some of this fruit was overlooked during the first grading and that, therefore, this does not represent a net increase in culled fruit.[7] On the other hand, it was observed at the time of grading and regrading of this fruit that the amount of doubtful fruit passed was much higher at the second grading than at the first and that in some cases a grading as rigid on the second run as on the first run would have caused considerably more fruit to be discarded as culls. Therefore, the loss in value as a result of the waiting period is more likely to have been understated than overstated.

Sizing of the culls removed at the time of regrading showed that these were largely from the colossal and jumbo grades, i.e., from the larger and more mature grades under consideration. The fruit graded mammoth was not culled in either case. In test II as shown in Figure 4, 4.5 per cent of the original weight of fruit was graded out as cull from the lot which was held in the plant. Forty-nine per cent of these culls graded colossal in size. On the orchard part of this test, 40 per cent of the culls graded colossal and 37 per cent graded jumbo. Many of the culls which graded jumbo were quite shriveled and undoubtedly would have graded colossal four days earlier at the original grading.

Summary

In summary, it appears from observations made during the 1952 season that fruit loses in weight and size after picking from the tree. There is a greater loss in weight and in size from fruit left in the orchard where it is subjected to higher day-time temperatures, lower humidity, and drying winds. Storage in the plant under the conditions observed caused a smaller loss in weight and grade but it may be that for fruit stored outside the plant this would not have been the case. Storage at high temperatures with no air circulation might in some cases cause overheating of the fruit and sweating which would cause a more rapid breakdown in fruit quality. The loss in weight and size is noticeable after a period as short as 20 hours. The loss in value of fruit stored for only this period ranged from $1.50 to $5.00 per ton. Loss of weight and size after picking can be reduced by movement into proper storage and minimized by grading as quickly after picking as possible.

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[7] Damage causing cullage on the regrading was not of the type which could have occurred during the first grading.

[illegible]

On the other hand, it was observed at the time of grading and regrading of [illegible] run as in the first run would have caused considerably more fruit to be discarded as culls. Therefore, the loss in value as a result of the waiting period is more likely to have been underestimated than overestimated.

Sorting of the culls removed at the time of regrading showed that those were largely from the colossal and jumbo grades, i.e., from the larger and more mature grades under consideration. The fruit graded mammoth was not culled in either case. In test II as shown in Figure 4, 4.5 per cent of the original weight of fruit was graded out as cull from the lot which was held in the plant. Forty-nine per cent of these culls graded colossal in size. On the orchard part of this test, 40 per cent of the culls graded colossal and 31 per cent graded jumbo. [illegible] have graded colossal four days earlier at the original grading.

[illegible]Y

In summary, it appears from observations made during the 1952 season that fruit loses in weight and size after picking from the tree. There is a greater loss in weight and in size from fruit left in the orchard where it is subjected [illegible] the plant under the conditions observed caused a smaller loss in weight and grade but it may be that for fruit stored outside the plant this would not have been the case. Storage at high temperatures with no air circulation might in some cases cause overheating of the fruit and shrinking which would cause a more rapid breakdown in fruit quality. The loss in weight and size is noticeable after a period as short as 20 hours. The loss in value of fruit stored for only this [illegible] can be reduced by movement into proper storage and [illegible] quickly after picking as possible.

[illegible] regrading was not of the type which could [illegible]

METHODS OF ACCOUNTING TO GROWERS FOR FRUIT DELIVERED[8]

The Separate-Lots System

Procedures

The operations in olive plants in the Corning area are based on a system which retains the identity of separate lots received from different growers until they have passed across the grading and culling belts so that the fruit falling into each grade can be weighed and credited to the proper grower. This system has the advantage of crediting each grower with the grade out from every lot of fruit which he delivers to the plant and prevents the mixing of products from several growers. It has the disadvantage of being more costly in some instances and of requiring more time than would a system which permitted sampling of each lot received at the plant and the running of all fruit received as a continuous lot across the large grader.

The separate-lot system requires a break in time between individual lots to permit the clearing of hoppers and grading and sorting belts. At these times some of the personnel in the plant are idle or working at a slower pace while others are working at an accelerated pace or added numbers are required to cut down the length of the break period. To permit separate weighing of the fruit to be credited to each grower from a particular lot, it is necessary either to keep all the fruit from a particular lot in small boxes and reset all empty boxes before the next lot comes over the grader or, in those cases where fruit is run from the sorting tables into large tubs or bins, the bins must be moved to the scale at the end of every lot and back into position near the grader to receive the fruit from the next lot.

Time Loss

The loss of effective working time depends on such factors as the plant volume per hour, the average size of lot for individual growers, and the length of the delay or break-for-lot period. Table 6 summarizes the results of studies of separate-lot systems in eight plants receiving olives for processing during the 1952 season. The breaks-for-lot time averaged from two to five minutes in different plants while breaks for individual lots in all plants ranged from one to ten minutes.

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[8] For additional information on this topic, see Bressler, R. G., and B. C. French. "Efficiency in Fruit Marketing." California Agriculture, vol. 7, nos. 2 and 3, February and March, 1953.

TABLE 6

The Effects of the Separate-Lot System on Effective Working Time in Eight Olive Plants

Plant	Volume of fruit		Lots run per plant hour	Break time per lot	Loss of effective working time	
	Per plant hour	Per lot			Per hour	Per cent
	1,000 pounds			minutes		
I	3.1	2.0	1.5	2.9	4.5	7.5
II	13.3	4.6	2.9	2.7	7.9	13.2
III	10.0	1.8	5.4	2.0	10.9	18.2
IV	11.8	2.8	4.2	3.4	14.2	23.7
V	10.5	5.3	2.0	2.3	4.6	7.7
VI	7.2	2.9	2.5	4.2	10.6	17.7
VIII	5.2	2.8	1.9	4.9	9.1	15.2
IX	12.3	3.2	3.9	3.6	14.0	23.2

Size of Lot

Size of lot delivered is determined primarily by the size or production characteristics of the individual grower. Plant managers can affect size of lot graded by (1) scheduling picking and hauling operations from orchards so larger average deliveries at the plant will result, (2) consolidating several truck-loads from the same grower into a single lot at the plant, and (3) discouraging very small growers or combining the fruit from several small growers into a single lot for the purposes of plant accounting.

Lots of fruit received by individual olive plants averaged from 2,000 to more than 5,000 pounds. These averages were greatly influenced by a few relatively large cases while many lots were very small. Individual lots observed during the study ranged from 400 to 26,000 pounds; 25 per cent of all lots were less than 1,000 pounds and 32 per cent between 1,000 and 2,000 pounds.

Table 6 also indicates the effect of the separate-lot system on effective working time. Time loss ranged from 7.5 per cent in Plant I to 23.7 per cent in Plant IV. The large losses in Plants IV and IX are due to small lot size relative to plant volume and so to relatively large numbers of breaks per hour. Plant I has the lowest average lot size of all the plants studied,yet, has the lowest time loss, due to the very low plant volume per hour and the related small number of lots run per hour.

Sample Grading System

Procedures

An alternative to the break-for-lots system which maintains the individual identity of lots of fruit through grading and weighing is the system which bases payment to the grower on total weight of fruit and on percentages in each size grade determined by the grading of a sample drawn from the fruit delivered and run on a sample grader.

A sample is drawn from each lot of fruit. Having established the total weight of fruit delivered and taken a sample to be used in determining the percentage falling in each of the several size classes, the plant operator can then pool the fruit with the fruit of other growers since there is no further need to maintain the identity of the individual lots delivered.

At the present time two different methods are being followed in sampling olives in other areas of the state. One of these draws a sample from each box as it is unloaded from the truck at the receiving plant. A second sampling procedure now in use involves a mechanical diversion of a small portion of the olives dumped from every box or diversion from a continuous stream of olives moving along a belt after the fruit from individual boxes has been thoroughly mixed by going over a stemmer or trash remover. This differs from the other method of collecting a sample in that it is mechanical in an attempt to remove the human error in sampling but further in that the fruit is sampled not at the time when it is received at the plant but at the time when it is run across the grader. Regardless of which sampling method is used, the samples are then set aside and graded over a sample grader by plant personnel. The bulk of the lot, after the sample is drawn, can move on through the plant with no further attempt to maintain its identity.

With a sampling system it is not necessary to stop the grader and other sorting machinery between individual lots. In the sampling system which draws a mechanical sample,it is necessary only to clear enough of the machinery to permit a break in the flow of fruit on the belt. In either case the principal change at the grader lies in the fact that sorting personnel do not wait while the machine is shut down to permit the weighing of olives within separate grades for each individual grower. Fruit is weighed after sorting, if at all, only when bins or trucks of fruit have been filled to capacity and are en route from the grader to storage vats. In the case of a fully mechanized operation, the fruit can be run from the end of the sorting belt on to conveyors and conveyed directly to the vat without delay for weighing in individual lots.

[illegible]

[illegible]

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The aim of both the separate-lot system and the sample grading system is to provide a basis for accurate payment to growers for their fruit. Under a sample grading system, the accuracy is affected by the method of sampling and the size of sample relative to the size of the lot or the total amount of fruit delivered by a grower during the growing season.

Because of the variation that exists among boxes of fruit from different trees within an orchard and even among boxes taken from a particular tree, it would appear that a sampling system which merely selects certain boxes from a truckload would not give sufficiently accurate results in the grading of Sevillano olives. Sampling which provides convenient and unbiased methods of sampling the entire lot at random would be preferred. Mechanical sampling devices would appear to be the best means of achieving these ends, but neither the mechanical nor the manual removal of samples was tested statistically as part of this study.

Sampling by drawing some olives from every box or mechanically drawing a fixed percentage from a large lot may give a sample which is larger than is desired for sample grading. Drawing from the entire lot should give a more accurate estimate of the true proportions in the various sizes, but this degree of accuracy may be reduced in subdividing the sample to reduce the cost of grading or to obtain a standard size of sample--e.g., 100 ounces--for greater speed, ease, and accuracy of calculations. Failure to accurately subdivide the sample may cause an estimate of grades different from that which would be obtained from a carefully drawn sample. For example, in pouring a part of a sample of Sevillanos from one box to another, the "shotberries" which are round would roll more freely than other olives less regular in shape, and the two portions of the sample would give different estimates of size distributions. Another practice which might cause a biased sample is the use of cupped hands or other such scoop to remove a sample for grading from a larger sample. Because of the extreme range in the size of Sevillanos, the scoop might be held open at the bottom by a large fruit which would permit some of the very small olives to fall from the scoop and remain in the original box, and the sample for grading would overestimate the proportion of large sizes in the sample originally drawn.

Size of Sample

The size of sample taken from a lot affects the accuracy of the estimates of fruit in each grade. The distribution of sizes in the sample may differ somewhat from the true distribution of sizes for all the fruit delivered by the grower, The aim of both the separate-lot system and the sample grading system is to provide a basis for accurate payment to growers for their fruit. Under a sample grading system, the accuracy is affected by the method of sampling and the size of sample relative to the size of the lot or the total amount of fruit delivered by a grower during the growing season.

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but the magnitude of such differences can be reduced by increasing the size of the sample. Adjusting the size of sample to the size of total lot makes it possible to limit possible error to within a predetermined amount.

Relationship between size of sample and total weight of lot for several designated degrees of accuracy is shown in Figure 5. The curves in this diagram are based on the assumption that representative samples are obtained and that advance estimates are available concerning minimum season deliveries per grower. Nothing is known or assumed about the probable proportions of fruit falling in each grade. Accuracy of the estimate is expressed as a per cent of the total weight of fruit of all grades and is considered in relation to total deliveries per season rather than for each lot. For example, if the admissible error is limited to 1 per cent and the grower delivers 750 pounds of fruit per season (30,000 olives), the per cent to be sampled from each lot would be 24.3 per cent.[9] For larger seasonal deliveries the per cent required for a given accuracy in sampling is smaller. With deliveries of 2,500 pounds of fruit the same accuracy could be obtained with a sample of 9.6 per cent.

As the desired degree of accuracy increases, the required per cent to be sampled also increases. The required sample for a 1-per cent limit of error for 7,500 pounds of fruit would be 3.1 per cent, but for a .5-per cent limit of error, it would be 11.3 per cent.

The limits of admissible error shown in Figure 5 represent upper limits that rarely will be reached or exceeded. These limits are based on a probability of attaining an error of estimate which would not be exceeded in more than 5 per cent of the cases. If the admissible error is to be limited to 1 per cent and the true proportions for the peak size grade are 40 per cent, i.e., if 40 per cent of the seasons deliveries by this particular grower fall into a given size class, say, colossal, then the estimated proportion of this grade based on the sampling procedure would be expected to fall within 39 per cent and 41 per cent in 95 per cent of the cases. A grower delivering 20,000 pounds of olives of which 8,000 pounds were colossal could expect an estimate falling within 100 pounds of this amount 68 per cent of the time and within 200 pounds 95 per cent of the time. The average error for a number of lots of this size would be about 80 pounds.

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[9] The conversion factor used for Sevillano olives was 40 to the pound. This figure is lower than one would probably find in actual practice, but use of this low figure in estimating the number of fruit insures a sample larger than necessary to be sure that the error is limited to the desired range.

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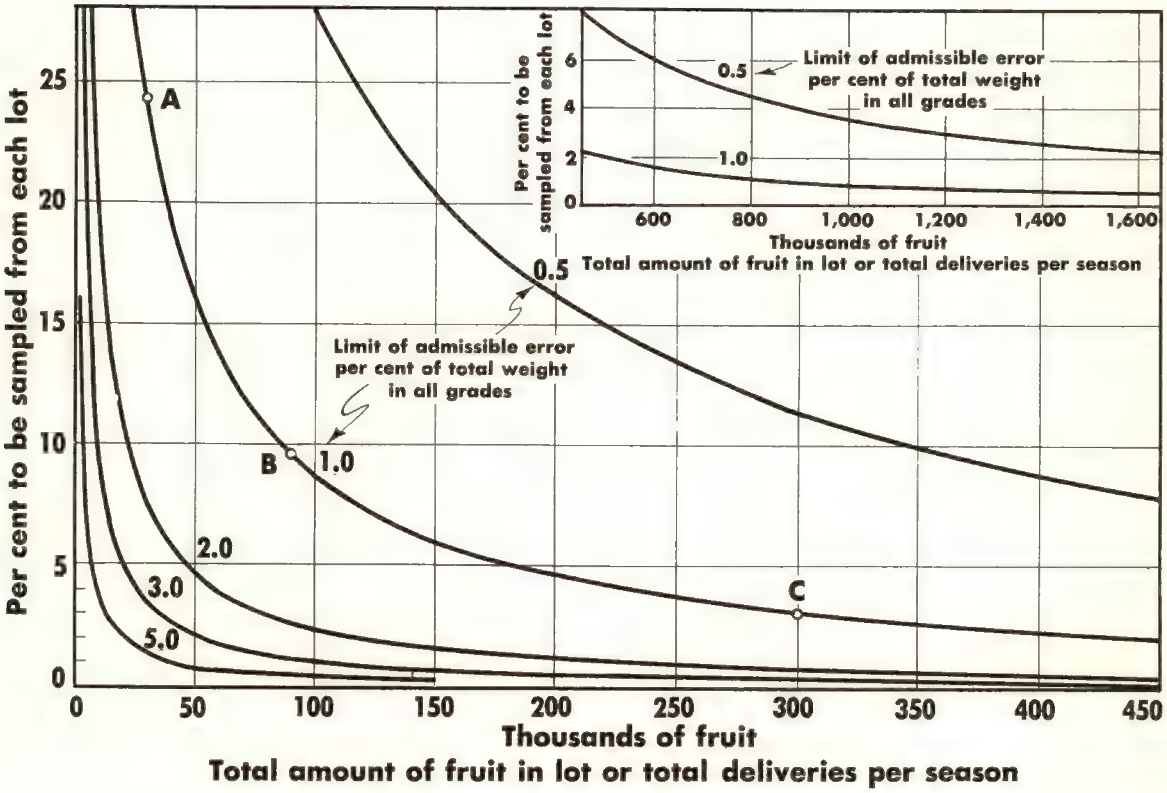

FIGURE 5. RELATIONSHIP BETWEEN TOTAL AMOUNT OF FRUIT IN LOT OR TOTAL DELIVERIES PER SEASON AND PER CENT TO BE SAMPLED FROM EACH LOT FOR GIVEN LIMITS OF ADMISSIBLE ERROR.

The effect of the desired degree of accuracy on the volume of fruit sampled and the cost of sample grading for a typical olive packing plant is shown in Table 7. To obtain the 2-per cent limit of admissible error, it would be necessary to sample 5.6 per cent of the deliveries of a grower who delivered a total of 1,000 pounds per year. This same grower, in order to receive a 1-per cent limit of admissible error, would need a sample of 19.3 per cent or for an 0.5-per cent limit of admissible error, a sample of 49 per cent. As the total deliveries per grower per season increase, the percentage required to be sampled for any given limit of admissible error falls rapidly. For example, a grower who would deliver 20,000 pounds of fruit per year would need to have 1.2 per cent of that fruit sampled to be within a 1-per cent limit of error or a 3/10 of 1-per cent sample in order to be within a 2-per cent limit.

TABLE 7

The Effect of the Desired Degree of Accuracy on the Volume of Fruit Sampled and the Cost of Sample Grading for a Typical Olive Packing Plant

Deliveries per grower per season	Number of growers	Total deliveries per season	Total sample									
			Limit of admissible error (per cent of total weight)									
			5.0		3.0		2.0		1.0		0.5	
1,000 pounds		1,000 pounds	per cent	pounds	per cent	pounds	per cent	pounds	per cent	pounds	per cent	pounds
1[a]	5	5	0.9	45	2.5	125	5.6	280	19.3	965	49.0	2,450
5	7	35	0.2	70	0.6	210	1.1	385	4.7	1,645	16.2	5,670
10	10	100	0.1	100	0.3	300	0.5	500	2.4	2,400	8.9	8,900
20	8	160	0.1[b]	160	0.1	160	0.3	480	1.2	1,920	4.6	7,360
50	5	250	0.1	250	0.1[b]	250	0.1	250	0.5	1,250	1.9	4,750
100	5	500	0.1	500	0.1	500	0.1[b]	500	0.3	1,500	1.0	5,000
200	1	200	0.1	200	0.1	200	0.1	200	0.1	200	0.5	1,000
	41	1,250	0.1	1,325	0.1	1,745	0.2	2,595	0.8	9,880	2.8	35,130
Total sampling cost			$192		$202		$222		$397		$1,003	

[a] Average of 40 Sevillano olives used to calculate the number of fruit.

[b] A minimum size sample of 0.1 per cent of each lot of fruit delivered is indicated for practical reasons, although the theoretical size of sample would continue to decrease as total deliveries per season increase.

Considerations in Changing Grading Systems

The use of a sample grading procedure would have some advantages over the break-for-lot system of grading now being used in the Sevillano olive plants in northern California. Observation and analysis establish the fact that it is possible to obtain a sample that will permit fair estimates of the true proportions of olives delivered by growers for sale. Given these facts, however, further consideration is necessary before it can be said conclusively that any given olive packing plant should make a change from a break-for-lots to a sampling system.

Growers raise the question as to whether, even though an accurate sample can be taken, the entire sampling and sample grading procedure will give them a grade out which is as accurate as that which they have been receiving from large plant graders in past years. The buyer of olives is interested in a procedure which will give him a grade out sufficiently accurate to satisfy his grower suppliers and thus avoid misunderstandings over the true grade of fruit delivered, and he is also interested in the comparative costs of grading under the two systems. Consideration of a change to sample grading by a plant operator involves analysis of (1) the increase or decrease in capital investment as machinery is purchased for sample grading, (2) the possible increase or alteration in use in some of the facilities presently on hand, and (3) the effect upon direct or variable costs of operation. Both the grower and the packer are interested in any other advantages or disadvantages of one system over the other.

One of the important items involved in a sample grading system is the device used to size the sample after it is drawn from the large lot. This may be either a small grader designed and built primarily for this purpose or it may be a full size grader such as those now used in the plants for sizing large lots but stripped down to the bare essentials necessary to permit a belt for culling and the cable grader necessary for sizing the samples. An important fact to be established is whether or not these sample graders can be as accurate in their sizing as the large graders.

Field Testing of Sample Grading Machines

Extensive tests were made of the accuracy of two sample graders in plants in the Corning area during the 1952 harvest season. Both of these graders were of the spiral roller type designed specifically for the grading of small quantities of olives. They had been built by packers for the purpose of investigating the feasibility of using such machines for grading samples. The primary objective

of the tests conducted in this study was to determine the variability which could be expected from the sample machines rather than the degree of correlation of those machines with the large graders in the plants where they were located.

Samples for running over these graders were drawn from regular lots of fruit as they were run across the large grading machines. An attempt was made to collect an unbiased sample by dipping from a continuous stream on a belt or from some point where the olives were falling free from one part of the sorting mechanism to another. These samples were then run over the small graders one or more times, and analysis was made of these grades both within those given by the sample grader and relative to those given by the large plant grader. A total of 70 lots was sampled, and 127 grading runs were made over the two sample graders.

On one machine using a sample which was 0.15 per cent of a 7,500-pound lot, the per cent falling into the peak grade of jumbo varied from 44.2 to 46.8 per cent of the total lot for five runs across the sample grader. In terms of calculated payments to the grower, using 1952 prices, these five runs on the sample grader would have varied from $164 to $167 per ton. The amount paid by the packer for this lot of olives based on grading by his large grader was $164 per ton.

There was a significant difference in the mechanical accuracy of the two machines tested. However, each could be improved considerably with minor mechanical alterations. On one of these machines, which will be called machine I, comparison of the result obtained by running the same sample across the grader two times showed that two-thirds of the time one would expect that a second observation would not differ by more than 76 cents per ton from the first observation. Furthermore, 95 per cent of the time, nineteen out of twenty times, this machine would be expected to give a second reading which was within $1.52 of the value per ton of the first grading. These tests were made by calibrating the machine and then continuing to run all these lots without further changes in setting. Counts per pound were taken each time to make certain that the size grades being obtained were within the tolerances allowed by the standards. With this potential for repetition, it would be possible after calibrating this machine to be certain that one was within these limits. In other words, the error in the actual grading by the machine would be slight. The variation obtained here did not include any sampling variation since these pairs were run on the same sample. However, they did include the error of the machine plus any errors made in weighing the fruit.

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Machine II showed more variation. On paired runs with this machine, two-thirds of the time one would expect that a second observation would vary by not more than $2.00 over or under the first reading, while 95 per cent of the time, the total expected variation would be within $4.00, above and below the first grading. Again, these variations include any errors made in weighing and recording as well as errors made by the grader. Careful mechanical adjustment of the machine, plus careful weighing, would reduce this limit of error.

The above discussion is in terms of single lots in which errors resulting from pure chance in weighing and grading could be expected to be both above and below the true values sought. These errors would tend to offset each other in any large number of cases, and any variation in the grading and value received from individual lots would tend to be reduced when a large number of lots were combined. The grower then could expect that extreme variations among individual lots would offset each other and, for the season, the net effect of chance errors for any grower or for any plant should be considerably less than the ranges noted above. Consistent bias either in sampling, grading, or weighing could be minimized or eliminated by careful design of the sampling system and continuous checking to prevent errors from creeping into the procedure and operations.

Comparison of results from the sample grader with results from plant graders now in operation is made difficult by the absence of an absolute standard which can be used to test the accuracy of both graders. In comparing the accuracy of the sample grader and the large grader, sources of variation in addition to those noted above must be considered. These include any errors in grading by the large grader and errors made in weighing and recording the grades obtained from the large grader. In spite of this possibility of compounded error, a comparison of fruit graded on sample grader II and a large plant grader indicated that, in two-thirds of the cases, the sample grader gave a value for the fruit which was within $3.74 of the average value per ton obtained from the large grader. This measure of error was $4.19 per ton when sample grader II was compared with a second large grader. Similarly, comparisons of sample grader I compared with a large grader indicated that, in two-thirds of the cases, the sample grader could be expected to give a value within $3.64 per ton of the value obtained from the large grader. Again, it should be pointed out that careful sampling, handling and weighing, and close mechanical adjustment of the sample graders would increase the accuracy of these estimates.

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As noted above, variations observed in comparing the accuracy of two graders, whether they be sample graders or plant graders, may be caused by the inaccuracy of either grader. Data were presented which indicate variations in grade obtained in repeated runs of the same lot of fruit over sample grading machines. Similar results were obtained from repeated runs of the same fruit on a large grader. In a test on one, regrading 510 pounds of olives which were size graded 55 per cent colossal and 45 per cent jumbo on the first run gave the following:

Type	First grading	First regrading	Second regrading
	per cent		
Supercolossal	0	2.8	4.6
Colossal	55	47.4	47.0
Jumbo	45	43.5	42.2
Giant	0	6.3	6.2

No changes were made in grader settings. The average value per ton for these three gradings would have been $115.56, $111.22, and $116.02, respectively.

These data do not permit statistical determination of the results which could be expected from a greater number of regradings on a large grader, but the range in this one test and other observations made during the 1952 season indicates that the sample graders tested will grade fruit as accurately as the large plant graders now in use. Sample graders may in fact be more accurate for the factors causing variation in grading can be more easily controlled.

Comparative Costs of Break-For-Lot and Sample Grading Systems

If a system of sample grading is designed to be sufficiently accurate to satisfy both the grower and the buyer of olives, then the second most important consideration in choosing between the two systems is their comparative costs. Such comparative costs vary greatly for the different plants depending upon the present organization, the amount of labor used, and the extent to which breaks-for-lot have been reduced to a minimum. The effects of the separate-lots system on potential plant volume and on direct labor cost are shown in Table 8. Based on plant volume per hour and direct plant payroll under the present system with separate-lots and a potential system with no separate-lots, the labor cost per 1,000 pounds is shown to be from 32 to 80 cents per 1,000 pounds more for the separate-lots system. All plants show some increase in volume per hour in

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Jumbo	45	43.5	42.3
Small	0	6.5	6.2

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These data do not permit statistical determination of the results which could be expected from a greater number of regradings on a large grader, but the results in this one test and other observations made during the 1952 season indicate that the sample graders tested will grade fruit as accurately as the large plant graders now in use. Sample graders may in fact be more accurate for the factors causing variation in grading can be more easily controlled.

Comparative Costs of Break-For-Lot and Sample Grading Systems

If a system of sample grading is designed to be sufficiently accurate to satisfy both the grower and the buyer of olives, then the second most important consideration in choosing between the two systems is their comparative costs. [illegible] present organization, the amount of labor used, and the extent to which break-for-lot have been reduced to a minimum. The effects of the separate-lots system [illegible] on plant volume per hour and direct plant payroll under the present system with separate-lots and a potential system with no separate-lots, the labor cost per 1,000 pounds is shown to be from 32 to 80 cents per 1,000 pounds more for the separate-lots system. All plants show some increase in volume per hour in contrasting the present and the potential systems, but the greatest increase in volume is shown by those which have the highest percentage of shutdown time shown above in Table 6. The saving in labor is based partly upon the increase in effective work time of the entire personnel of the plant and in some cases upon a reduction in number of personnel needed for operating a separate-lots system. In comparing the two systems, this decrease in labor would not be a net decrease in total amount of labor required since personnel would be needed to operate the sample grading mechanism.

TABLE 8

The Effects of the Separate-Lot System on Potential Plant Volume and on Direct Labor Costs in Eight Olive Plants

	Present--with separate-lots			Potential--no separate-lots			
Plant	Plant volume 1,000 pounds per hour	Direct plant payroll per hour	Labor cost per 1,000 pounds	Plant volume 1,000 pounds per hour	Direct plant payroll per hour	Labor cost per 1,000 pounds	Labor cost per 1,000 pounds for separate-lot system
		dollars			dollars		
I	3.1	11.40	3.69	3.4	11.40	3.37	0.32
II	13.3	24.90	1.87	15.3	23.60	1.55	0.32
III	10.0	28.70	2.87	12.2	25.30	2.07	0.80
IV	11.8	21.00	1.78	15.5	19.10	1.23	0.55
V	10.5	25.20	2.40	11.4	24.00	2.10	0.30
VI	7.2	17.80	2.50	8.7	16.60	1.91	0.57
VIII	5.2	17.40	3.35	6.1	16.30	2.67	0.68
IX	12.3	21.30	1.73	16.0	18.80	1.18	0.55

Estimated Labor and Equipment Costs for Sample Grading

The amount of labor and equipment required for a satisfactory sample grading setup will vary somewhat among individual plants depending upon the labor available and the volume of fruit handled per day. Two major items of equipment would be required: a sample grader of some type and a very accurate dial type bench scale. Estimated cost of these is given in Table 9 as $700 for the grader and $480 for the scale. Based on a standardized set of annual charges, as shown in the table, the estimated annual cost of equipment would be $160.

[illegible]

[illegible] time of the entire personnel of the plant and in some [illegible] reduction in number of personnel needed for operating a separate-lots system. In comparing the two systems, [illegible] in labor would not be a net decrease in total amount of labor required since personnel would be needed to operate the [illegible]

TABLE 6

The Effects of the Separate-lot System on Potential
Plant Volume and on Direct Labor Costs in
Eight Olive Plants

Labor cost per 1,000 pounds, separate-lot system	Labor cost per 1,000 pounds	Direct plant payroll	1,000 pounds per hour	Labor cost per 1,000 pounds	Direct plant payroll	1,000 pounds	Plant
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.1	I
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	II
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.0	III
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	IV
[illegible]	[illegible]	[illegible]	11.4	[illegible]	[illegible]	[illegible]	V
[illegible]	[illegible]	16.40	8.7	[illegible]	[illegible]	[illegible]	VI
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	VII
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

TABLE 9

Estimated Labor and Equipment Costs for Sample Grading

	Olive plants
Estimated installed cost of sample grading equipment, 1952[a]	
Grading table[b]	$ 700
Bench scales--dial type	$ 480
	$1,180
Estimated annual cost of equipment[c]	$ 160
Typical labor hours per 1,000 pounds of fruit in samples	20
Typical labor cost per 1,000 pounds of fruit in samples[d]	$ 24

a/ Does not include costs of mechanical devices for sample selection.

b/ The olive sizing-sorting table has a capacity of about 150 pounds per hour.

c/ Based on a standardized set of annual charges for depreciation, repairs, insurance, interest, and taxes; grading tables, 14.7 per cent; scales, 10 per cent plus $7.50 per year for repairs and maintenance.

d/ Based on typical average wage of $1.20 per hour for sample grading labor.

Typical labor hours per 1,000 pounds of fruit in samples as determined from 1952 operations are estimated at 20 hours per 1,000 pounds of sample. At $1.20 per hour, the labor cost per 1,000 pounds of fruit run over the sample grader would be $24. An estimate of the amount of fruit to be run over a sample grader during a season can be obtained from Table 7.

The costs of sample grading systems in relation to given degrees of accuracy for eight olive plants are given in Table 10. These costs are based on the volume per season as given by the plant, broken down to an average volume of deliveries per grower. With a 1-per cent limit of admissible error for the average size grower, the estimated costs of sampling vary from 16 cents per 1,000 to 56 cents

per 1,000 pounds of fruit in these eight plants. Costs are much higher when a 1/2 of 1-per cent limit of admissible error is sought. In this case the costs vary from 52 cents to 67 cents per thousand. As previously noted, sampling costs are influenced by the desired degree of accuracy, the amount of exact sampling information available, and the distribution of total deliveries among individual growers.

TABLE 10

Costs of Sample Grading Systems in Relation
to Degree of Accuracy for Eight Olive Packing Plants

Plant	Volume per season	Average volume of deliveries per grower	Average cost of sample grading			
			Limit of admissible error for the average size grower			
			Per cent of the total weight delivered			
			3.0	2.0	1.0	0.5
	1,000 pounds		dollars per 1,000 pounds of fruit received			
I	487	35	0.35	0.40	0.47	0.95
II	1,713	42	0.12	0.12	0.21	0.62
III	3,100	18	0.08	0.12	0.36	1.25
IV	1,527	26	0.13	0.15	0.32	0.92
V	2,098	46	0.10	0.10	0.20	0.56
VI	1,218	14	0.18	0.23	0.54	1.67
VIII	824	16	0.24	0.29	0.56	1.56
IX	2,409	56	0.09	0.09	0.16	0.52

The comparative costs of separate-lots and sample grading systems are illustrated by the diagram in Figure 6. With 1-per cent accuracy, estimated sampling costs were less than present costs of separate-lots systems in seven of the eight olive plants. If average break time were decreased to two minutes per break in all plants, the cost of sample grading would still be less than the cost of break-for-lots in five of the eight plants studied. If the limits of admissible error were reduced to 1/2 of 1 per cent, sampling costs would be higher than break-for-lots costs in all but one of the eight plants. With a limit of admissible error of 2 per cent, the cost of sample grading would be lower than the cost of break-for-lots system in all but the one plant which had the lowest plant volume in 1952.

per 1,000 pounds of fruit in these eight plants. Costs are much higher when a 1/2 of 1-per cent limit of admissible error is sought. In this case the costs vary from 52 cents to 67 cents per thousand. As previously noted, sampling costs are influenced by the desired degree of accuracy, the amount of exact sampling information available, and the distribution of total deliveries among [illegible]

TABLE 10

Costs of Sample Grading Systems in Relation to Degree of Accuracy for Eight Olive Packing Plants

Plant	Volume per season	Average volume of deliveries per grower	Average cost of sample grading Limit of admissible error for the average size grade			
		1,000 pounds	dollars per [illegible]			
[illegible]	[illegible]	35	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	42	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	18	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	26	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The comparative costs of separate-lots and sample grading systems are [illegible] sampling costs were less than present costs of separate-lots systems in seven of the eight olive plants. If average break time were decreased to two minutes per break in all plants, the cost of sample grading would still be less than the cost of break-for-lots in five of the eight plants studied. If the limits of admissible error were reduced to 1/2 of 1 per cent, sampling costs would be higher than break-for-lots costs in all but one of the eight plants. With a limit of admissible error of 2 per cent, the cost of sample grading would be lower than the cost of break-for-lots system in all but the one plant which had the lowest plant volume in 1952.

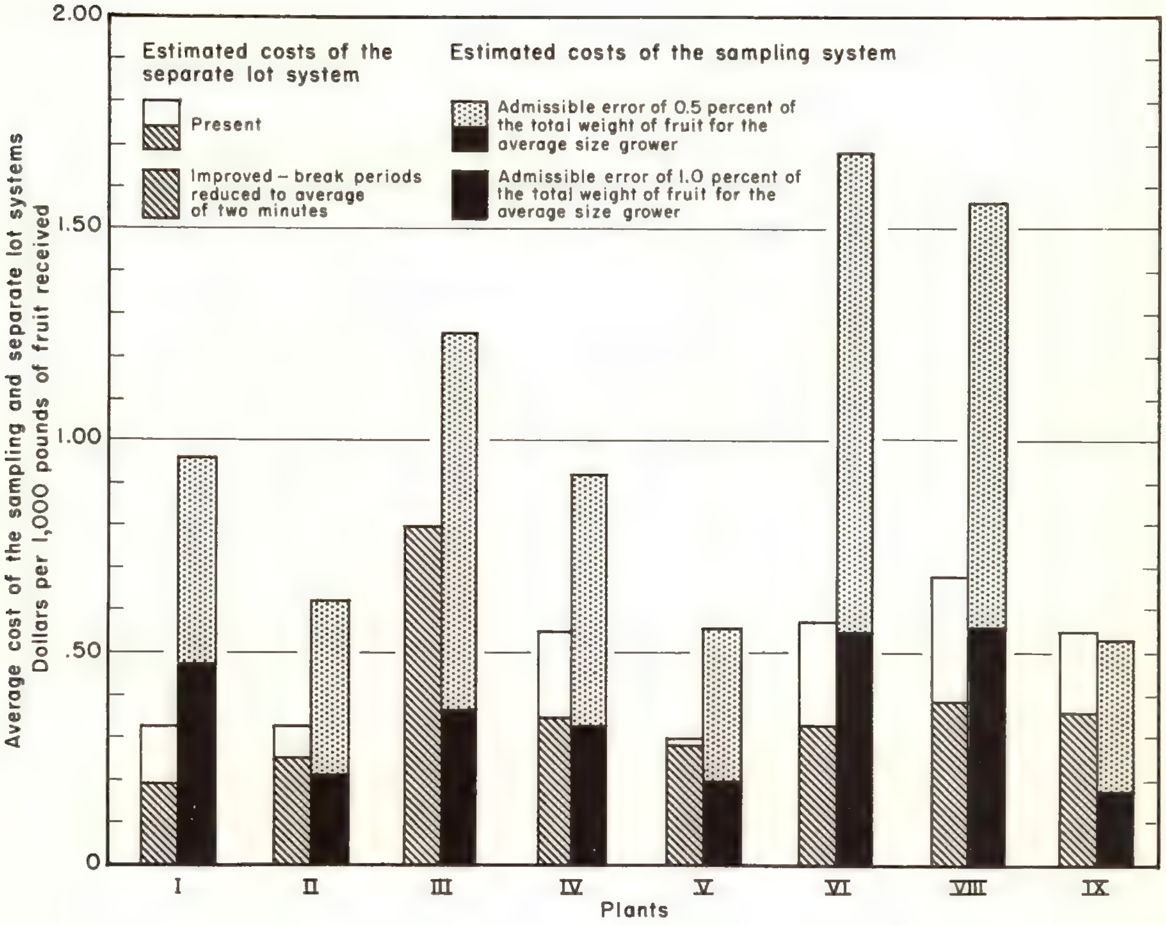

FIGURE 6. COMPARISON OF ESTIMATED COSTS OF SEPARATE LOT SYSTEMS AND SAMPLING SYSTEMS IN EIGHT OLIVE PLANTS.

These cost data are based on averages and estimates for all plants, and the actual decision as to whether to make an investment in sample grading equipment and the change in procedure to a sample grading system should be made on more detailed analysis within those plants where there appears to be a rather close margin of difference in costs between the two systems. Costs also may be affected by present equipment owned by the plant and, therefore, the amount of added investment necessary. The great variation in break-for-lots time and, therefore, loss of effective time indicate that most plants might be able to reduce the loss of effective time by altering present practices. The changes required would vary for the several plants depending upon present organization.

Advantages Other Than Costs

In addition to an analysis of the accuracy of a sample grading versus a break-for-lot grading system and the comparative costs of these two systems for the plant operator, both the grower and the plant operator should be interested in any further advantages in one or the other systems. Under a sample grading technique, it would be easier to adjust the sample graders to the peculiarities of a specific lot of olives and, therefore, a particular grower should be able to get a grade which more accurately represents the exact proportion of fruit which he delivers to the plant. Both the grower and the buyer should benefit by the saving in time which would permit fruit to be picked, graded, and placed into vats with a shorter time lag. This would increase the tonnage and the grade of fruit sold by growers and would increase the quality of fruit received by processors.

A further advantage to both parties would be the increased capacity of the present plant grading equipment due to the increase in effective working time; this should permit a given volume of fruit to be handled in a shorter period of time which might be necessary if many growers attempted to delay picking as discussed above. This increased plant capacity would also be useful in years such as 1948 when weather conditions delayed the entire crop.

These advantages might be sufficiently great to warrant the adoption of a sample grading system even though there was not a significant change in the cost of this versus the present system. Whether such a change should be made must, in the final analysis, come as an agreement between the individual packer and the growers who are supplying him with fruit. It cannot easily come from either side alone but must be jointly accepted. Any sample grading program would require very careful operations, including the best possible method of sample selection for any given plant setup and carefully controlled grading and weighing of the sample once it has been drawn.

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[illegible]

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These advantages might be sufficiently great to warrant the adoption of a sample grading system even though there was not a significant change in the costs of this versus the present system. Whether such a change should be made must, in the final analysis, come as an agreement between the individual processor and the growers who are supplying him with fruit. It cannot easily come from either side alone but must be jointly accepted. Any sample grading program would require very careful operations, including the best possible method of sample selection for any given plant setup and carefully controlled grading and validity of the sample once it has been drawn.

LABOR REQUIREMENTS AND COSTS OF PICKING

As a part of the study of olive harvesting, Hoffman and Shultis obtained accounting data from twelve growers on the costs of picking and hauling fruit to the plant.[10] The results of this study are summarized in Table 11. While the number of growers reporting is relatively small and the reports covered only a portion of the picking period during October, these data indicate the general level of costs incurred for these operations.

2.97

TABLE 11

The Costs of Picking and Hauling Sevillano Olives,
Corning Area, October, 1952

Orchard number	Age of trees	Pounds net per box	Rate paid per box	Picking cost	Super-vision	Hauling	Total harvesting cost
			dollars	dollars per 100 pounds			
7	20-60	48.8	1.25	2.32	.38	.27	2.97
14	40	42.0	1.00	2.35	[a]	.24	--
3	30	42.0	1.00	2.38	.09	.25	2.72
4	10	42.0	1.00	2.44	.76	.31	3.51
53	11	45.0	1.10	2.45	.27	.51	3.23
5	30	40.0	1.00	2.50	.05	.20	2.75
22	14	40.0	1.00	2.54	.20	.25	2.99
26	5-50	40.0	1.06 ave.	2.65	.13	.29	3.07
6	All	47.0	1.25	2.66	.20	.31	3.17
8	32	41.5	1.20	2.88[b]	--[b]	.21	3.09
9	25-30	41.0	1.25	3.05	.14	.19	3.38
39	50	41.5	1.50	3.63	.24	.24	4.10
Average				2.57	.25	.27	3.09

[a] Not reported.

[b] Contract, supervision included in picking cost.

In all cases, picking labor was paid on a per-box basis. The average net weights per box varied with different growers from 40 to 49 pounds per box, and payments ranged from $1.00 to $1.50 per box. Average picking costs for all growers reporting were $2.57 per 100 pounds of fruit. Costs for picking supervision ranged from $0.09 to $0.38 and averaged $0.25 per 100 pounds. The reported costs of hauling fruit to the plant and returning empty boxes to the

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[10] Hoffman, Robert M., and Arthur Shultis. Tehama County Olive Harvesting Study. January, 1953. 1p. Processed. (Calif. Agr. Ext. Serv.)

orchard rows varied from \$0.19 to \$0.51 and averaged \$0.27 per 100 pounds of fruit. Total costs of picking, supervision, and hauling ranged from \$2.72 to \$4.10 and averaged \$3.09 per 100 pounds.

The reported costs given above indicate the general level of picking and hauling costs, but they cover a wide range of orchard conditions and work methods. More detailed studies of picking and hauling operations were made in an effort to measure some of the factors affecting costs and to indicate the relative efficiency of different work methods. The results of these studies are reported below and in the following section on Orchard-to-Plant Transportation.

Studies of Picking Operations

Detailed studies were made of picking operations in nine orchards. In seven of the orchards the trees were picked clean in one picking, and in two orchards selective picking was practiced, with only the larger fruit being picked during the period of the study. The studies of individual pickers included observations on 150 different workers while picking 414 trees. With only two orchards following the practice of selective picking, the data on this method were considered inadequate and the results are not included in this report. From the remaining studies--involving 120 pickers and 258 trees--it was found that an average of 1.0 man-hours were required to pick a 40-pound box. Of the total work time, the pickers were idle or "delayed" 6.4 per cent of the time. Of the time spent actually working, 84 per cent was spent in picking fruit and 16 per cent in climbing ladders, moving ladders, emptying buckets, and in miscellaneous activities. The size of fruit averaged 49 olives per pound, and yield per tree averaged 2.35 boxes.

Labor Requirements in Relation to Picking Conditions

Using only the data from the seven orchards which practiced clean picking, an equation was derived which indicates how man-hours per box are affected by the size of fruit and the density of fruit on the tree.[11] Size of fruit was

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[11] The equation for average picking labor is:

$$H = 0.35 + 0.0074(C) + 0.00031(D)$$

in which "H" is the man-hours required on the average to pick a 40-pound box of fruit, "C" is the average number of olives per pound, and "D" is an index of fruit density, computed by dividing the tree "surface" by the number of boxes picked from the tree. Coefficient of determination for the regression equation is $\bar{R}^2 = 0.29$.

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Labor Requirements in Relation to Picking Conditions

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[11] The equation for average picking labor is:

$$[illegible]$$

in which "Y" is the man-hours required on the average to pick a 45-pound box of fruit, "C" is the average number of olives per pound, and "D" is an index of fruit density, computed by dividing the tree "surface" by the number of olives picked from the tree. Coefficient of determination for the regression equation is $R^2 = 0.29$.

measured in number of olives per pound, and fruit density was measured in terms of square feet tree "surface" per 40-pound box of fruit picked from the tree. Tree "surface" was estimated approximately as the curved surface of a cylinder of height equal to the height of the tree and having a circumference equal to that of the tree crown.[12/]

For the average picking conditions observed in the study--size count, 49 olives per pound, tree "surface" per 40-pound box, 729 square feet--the average net labor requirements are given by the picking labor equation as 0.94 man-hours per 40-pound box. The results of similar calculations for other tree conditions are summaried in Table 12 in which average net labor requirements per box corresponding to a given count per pound--shown in the column headings--are tabulated against tree "surface" per 40-pound box--shown in the left-hand column. This table indicates increasing labor requirements as the count per pound increases and as the tree surface per box increases. For example, with a count per pound of 40 and a tree surface per box of 200, labor requirements are 0.71 man-hours per box, but with a count of 60 and a tree surface per box of 1,400, labor requirements increase to 1.22 man-hours per box.

In the data from which the equation for picking labor was derived, the observed labor requirements ranged from 0.41 to 1.78 man-hours per 40-pound box. Statistical tests indicate that only 29 per cent of the variation in observed labor requirements is explained by the equation, the remaining variation being due to factors not included in the equation. It is likely that the major part of the unexplained variation is due to differences in the skill and effort with which different pickers worked. General observation of the picking operations showed a wide range in the rate of picking for different workers, even though tree conditions were the same. Had it been possible to account for variations in individual picker skill and effort, the proportion of variation explained by the equation undoubtedly would be much higher.

While this study leaves much to be desired from the standpoint of fully explaining the observed variations in picking labor per box, it does confirm the importance of two factors commonly recognized in the industry. Under some picking conditions, it may be desirable to make these factors the basis for adjustments in rates of payment for picking. As noted above, payments for picking are customarily on a "piecework" basis, which in itself tends to compensate for variations in skill and initiative. In addition, variations in the

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[12/] Tree "surface" is computed as follows: multiply average diameter of tree crown by 3.14 and then multiply this product by the estimated tree height.

measured in number of olives per pound, and fruit density was measured in terms of square feet tree "surface" per 40-pound box of fruit picked from each tree. Tree "surface" was estimated approximately as the curved surface of a cylinder of height equal to the height of the tree and having a circumference equal to that of the tree crown.[1]

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In the data from which the equation for picking labor was derived, the observed labor requirements ranged from 0.11 to 1.76 man-hours per 40-pound box. Statistical tests indicate that only 29 per cent of the variation in observed labor requirements is explained by the equation, the remaining variation being due to factors not included in the equation. It is likely that a good part of the unexplained variation is due to differences in the skill and effort with which different pickers worked. General observation of the picking operations showed a wide range in the rate of picking for different workers, even though tree conditions were the same. Had it been possible to account for variations in individual picker skill and effort, the proportion of variation explained by the equation undoubtedly would be much higher.

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[1] Tree "surface" is computed as follows: multiply average diameter of tree crown by 3.14 and then multiply this product by the estimated tree height.

TABLE 12

The Effect of Number of Olives per Pound and Tree "Surface" per Box of Fruit on Average Picking Labor per 40-Pound Box, Corning Area, 1952[a]

Olives per pound / Tree "surface" per box	40	45	50	55	60
square feet	man-hours per 40-pound box				
200	.71	.74	.78	.82	.85
400	.77	.80	.84	.88	.92
600	.83	.87	.90	.94	.98
800	.89	.93	.96[b]	1.00	1.04
1,000	.95	.99	1.03	1.06	1.10
1,200	1.01	1.05	1.09	1.12	1.16
1,400	1.07	1.11	1.15	1.18	1.22

[a] Estimates of labor required include time spent in moving ladders, climbing ladders, and moving to a new tree. Idle or "waiting" time is not included. To include waiting time, add 6.7 per cent to the estimates given in the table.

[b] Approximately the average count per pound and tree "surface" per box for the pickers studied. Observed averages were: count per pound, 49; tree "surface" per box, 749 square feet; and man-hours per 40-pound box, 0.94.

If this procedure were applied to an actual orchard, the practical solution would involve an average adjustment for the entire orchard or for separate blocks within the orchard. One difficulty to be overcome would be the lack of advance information as to the average count per pound and density of fruit on the trees.

piecework rate above and below an average rate might be used to compensate for unusual picking conditions. The amount of such variation could be estimated from the data presented in Table 12. For example, the net time requirement for the average picking conditions is given as 0.94 man-hours per box while the time for trees averaging 60 olives per pound and 1,000 square feet of "surface" per tree is given as 1.10 man-hours per box. If the piecework rate for average picking conditions were $1.00 per box, an appropriate rate for this orchard would be (1.10/0.94) = $1.17 per 40-pound box. Similar estimates could be made for other picking conditions.

Table 12

The Effect of Number of Olives per Pound
and Tree "Surface" per Box of Fruit on Average
[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

a/ Estimates of labor required include time spent in moving ladders, climbing ladders, and moving to a new tree. Idle or "waiting" time is not included. To include waiting time, add 6.7 per cent to the estimates given in the table.

b/ Approximately the average count per pound and tree "surface" per box for the pickers studied. Observed averages were: count per pound, 85; tree surface per box, 749 square feet; and man-hours per 40-pound box, 0.94.

If this procedure were applied to an actual orchard, the practical solution would involve an average adjustment for the entire orchard or for separate blocks within the orchard. One difficulty to be overcome would be the lack of advance information as to the average count per pound and density of fruit on the trees.

A satisfactory advance estimate of these factors could be obtained on the basis of tree measurements and fruit picked from a representative sample of trees in the orchard, and from this estimate, an adjusted piecework rate could be computed. The alternative would be to establish a base rate to be adjusted at the end of the picking period on the basis of tree measurements and the actual grade out of the fruit picked.

Improved Picking Methods

One objective of the picking studies was to obtain preliminary data on the possible use of picking platforms as a substitute for ladders. The study indicates that this is not likely to be a promising change in method. The proportion of working time spent by all pickers in climbing ladders, moving ladders, and emptying buckets averaged 16 per cent. Even though a large part of this time was saved through the use of picking platforms, the reduction in total labor requirements would be relatively small unless the platform would also permit a marked improvement in the actual picking operations. If only a small reduction were achieved in picking labor requirements, a relatively large investment for picking platforms would not be justified.

If mechanical substitutes for ladders are not a promising change, other changes in method might be considered, such as shaking. Evaluation of such a method would require further studies in regard to suitable types of equipment, the possible use of sprays to obtain a more uniform drop of the fruit, the effect of such methods on bruising and the amounts of bruising that would be tolerable, and studies of costs with the new method.

ORCHARD-TO-PLANT TRANSPORTATION

In general the procedures followed in transporting olives from the orchard to the processing plant are similar for all growers. In the orchard, full boxes of fruit are stacked along the orchard rows by the pickers. These boxes are loaded on a truck or trailer and hauled to the plant. At the plant a receipt is obtained and the boxes are set off on skids or, if the boxes are palletized in the field, the pallet loads of boxes are unloaded with a fork truck. Empty boxes are loaded at the plant by hand or with fork trucks, and the empty boxes are hauled to the orchard and distributed in the picking area.

The labor requirements for these operations depend on the distance from orchard to plant and on the methods and equipment used. Studies of five different methods indicate a range in labor requirements from 33 to 113 man-

minutes per 100 boxes when the orchard-to-plant distance is one mile and a range from 48 to 198 man-minutes per 100 boxes when the orchard-to-plant distance is five miles. The results of studies from which these estimates are drawn are summarized in Table 13.[13] This table gives estimates of labor requirements with five different hauling methods and for several variations within each method.

Variations in the methods using a two-man orchard crew are studied in which the trip between the orchard and plant is made with either a one- or a two-man crew, depending on the arrangements for unloading at the plant. Where the orchard-to-plant trip is made by one man, it is assumed that the second worker in the orchard loading crew performs other work when not working as a loader. For example, he may work as a picker or supervisor.

Types of Equipment and Work Methods

The different methods, classified by type of hauling equipment, are as follows.

Pickup Truck--Method A

With this method, a pickup truck is loaded directly in the orchard by a two-man crew consisting of a loader driver who drives the truck between loading points in the orchard and sets full boxes on the truck bed and a stacker who stacks the boxes on the truck. The loading crew operates in a similar manner in returning empty boxes to the pickers. The capacity of the pickup truck is 50 to 60 boxes.

Flat-Bed Truck and Orchard Trailer--Method B

With this method, an orchard trailer is loaded by a two-man crew in a manner similar to that described with the pickup truck. At the roadside, however, the boxes are transferred by hand to a flat-bed truck for transportation to the plant. Empty boxes are returned to the orchard on the flat-bed truck and transferred to the orchard trailer for distribution to the pickers. The capacity of the orchard trailer is about 100 boxes, and the capacities of the flat-bed trucks range from 216 to 320 boxes.

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[13] These estimates and other data regarding labor requirements for orchard-to-plant transportation given in this report are based on observation of the methods and equipment used to transport olives. The data thus obtained have been supplemented, where appropriate, with production standards obtained in an earlier study. For a more detailed analysis, see Sammet, L. L. Efficiency in Fruit Marketing, "Orchard-to-Plant Transportation." (Calif. Agr. Exp. Sta. Giannini Foundation of Agricultural Economics. Mimeographed Report 131)

Flat-Bed Truck--Method C

With this method, a flat-bed truck is loaded by a two-man crew directly from the picker stacks along the orchard row. Empty boxes are returned from the plant and distributed directly from the truck without rehandling in the field. The truck capacity is about 216 boxes.

Highway Trailer--Method D

With this method, a tractor-drawn, four-wheeled trailer is loaded directly from the picker stacks by a two-man crew, and the boxes are hauled directly to the plant on the trailer. The load capacity per trailer is 108 boxes. With a two-trailer train, the load capacity is 216 boxes.

Low-Bed Highway Trailer--Method E

The procedure with this method is similar to Method D, except that the trailer bed is close enough to the ground to permit convenient loading with a one-man crew. The single crewman acts as a loader driver both in loading full boxes and in distributing empty boxes. This method was not observed in the studies of olive harvesting, but it is used by some pear growers. Under some circumstances, it could prove advantageous in hauling olives.

Labor Requirements

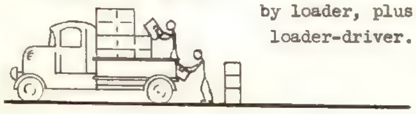
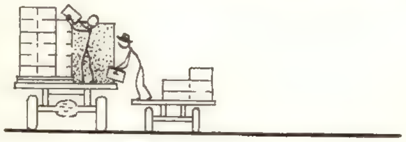
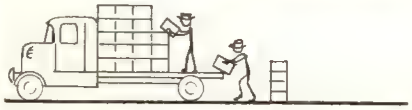
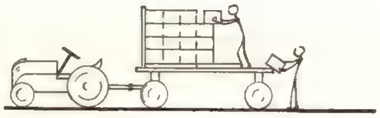
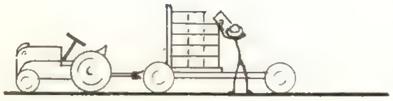
A summary of labor requirements with the above methods is given in Table 13. For each method this table gives estimated labor requirements for loading and hauling operations in the orchard, for the labor expended in highway travel, and for the grower's labor used in the receiving operations at the plant. The table also shows the effect on labor requirements if the size of load is varied and if the methods used in receiving at the plant are varied. To obtain comparability between labor requirements with equipment of different load capacities, all of the estimates in Table 13 are expressed in terms of labor required per 100 boxes. Comparison of specific methods can be made by close study of the table. Several general observations are given below.

Orchard Loading Labor

Labor requirements for loading and hauling work performed in the orchard with different equipment and methods are summarized in column 5 of Table 13. These estimates include the labor required to load full lugs, distribute empty lugs, drive between loading points, tie the load, and perform minor miscellaneous

TABLE 13

Average Labor Requirements for Orchard-to-Plant Transportation with Different Types of Equipment and Work Methods

Equipment and methods		On-highway crew	Load-size boxes per trip	Labor at orchard	Grower's labor at plant[a]	On highway per mile one-way distance[b]	Total labor per round trip	
In orchard	At plant						One-way distance 1-mile	One-way distance 5-miles
				man-minutes per 100 lugs				
1	2	3	4	5	6	7	8	9
A. PICKUP TRUCK. Loaded in orchard by loader, plus loader-driver. 	Orchard crew stack boxes on skid or pallet	2	60	49	43	21.1	113	198
	Pickup driver and receiver. Stack boxes on skid or pallet	1	60	49	26	10.5	86	128
B. FLAT-BED TRUCK. Loaded at roadside from orchard trailer by loader, plus loader-driver. 	Orchard crew stack boxes on skid or pallet	2	216	75	37	5.8	118	141
	Truck driver and plant receiver stack boxes on skid or pallet	1	216	75	20	2.9	98	110
	Boxes palletized in field, truck unloaded by fork truck	1	216	75	7	2.9	85	96
	Orchard crew stack boxes on skid or pallet	2	320	72	36	4.0	112	128
	Truck driver and plant receiver stack boxes on skid	1	320	72	19	2.0	93	101
	Box is palletized in field, truck unloaded by fork truck	1	320	72	6	2.0	80	88
C. FLAT-BED TRUCK. Loaded directly in orchard by stacker, plus loader-driver. 	Orchard crew stack boxes on skid or pallet	2	216	36	37	5.8	79	102
	Truck driver and plant receiver stack boxes on skid or pallet	1	216	36	20	2.9	59	70
	Boxes palletized in field, truck unloaded with fork truck	1	216	36	7	2.9	46	58
D. HIGHWAY TRAILER. Loaded directly in orchard by loader, plus loader-driver. 	Orchard crew stack boxes on skid or pallet	2	108	42	40	15.6	98	160
	Driver and plant receiver stack boxes on skid or pallet	1	108	42	22	7.8	72	103
	Orchard crew stack boxes on skid or pallet	2	216	36	37	7.8	81	112
	Driver and plant receiver stack boxes on skid or pallet	1	216	36	20	3.9	60	76
E. LOW-BED HIGHWAY TRAILER. Trailer loaded directly in orchard by loader-driver. 	Driver and plant receiver stack boxes on skid or pallet	1	108	26	22	7.8	56	87
	Boxes palletized in field, trailer unloaded by fork truck	1	108	26	9	7.8	43	74
	Driver and plant receiver stack boxes on skid	1	216	22	20	3.9	46	62
	Box is palletized in field, trailer unloaded by fork truck	1	216	22	7	3.9	33	48

[a] Includes allowances for performance of all necessary receiving operations at the plant, plus a minimum allowance of 1.5 minutes daily per trip. In some instances, considerably longer delays may be encountered.

[b] Based on the following average road speeds: trucks, 17.7 miles per hour when loaded with full boxes and 20.5 miles per hour when carrying empty boxes; tractor-drawn trailers, 12.4 miles per hour with full boxes and 16.7 miles per hour with empty boxes.

operations. The range in labor requirements runs from a low of 22 man-minutes per 100 boxes with Method E--the low-bed highway trailer--through an intermediate level of 36 man-minutes per 100 boxes with Method C--in which a truck of 216-box capacity is used on a direct haul from orchard row to plant--to a high of 75 man-minutes per 100 boxes with Method B--in which a flat-bed truck of 216-box capacity is used in combination with an orchard trailer. Contrasting these three estimates, labor requirements are least with Method E, in which a one-man loading crew handles each box only once; they are at an intermediate level with Method C in which--with a two-man crew--each box is handled twice in loading; and labor requirements are highest with Method B, in which--with a two-man crew--each box is handled twice in loading the orchard trailer and rehandled in transferring boxes between the orchard trailer and highway truck.

The figures in column 5 of Table 13 also indicate a slight variation in labor required in the orchard as size of load varies. For example, with Method B the labor required in the orchard is 75 man-minutes per 100 boxes when the load size is 216 boxes and 72 man-minutes per 100 boxes when the load size is 320 boxes. This reduction in labor requirements for the larger load results from spreading the fixed time requirements, such as driving to the first load point and tieing the load, over a larger number of boxes.

Grower's Labor at Plant

Estimates of the grower's labor required at the plant with different types of hauling equipment are given in column 6 of Table 13. These estimates range from 6 man-minutes per 100 boxes when a fork truck is used to unload a field palletized truckload of 320 boxes to 43 man-minutes per 100 boxes when a two-man grower crew--without assistance from the plant--transfers the boxes by hand from a pickup truck of 60-box capacity. With a given type of hauling equipment, the labor expended by the grower at the plant is reduced if the plant assists in hand stacking the boxes on skids or if the boxes are field palletized and unloaded at the plant with a fork truck. For example, when 216 boxes are hauled per load with Method B, the grower's at-plant labor is 37 man-minutes per 100 boxes if the boxes are stacked on pallets by a two-man grower crew without assistance from the plant. With the same equipment but with a one-man grower crew assisted by a plant receiver, the grower's at-plant labor is only 20 man-minutes per 100 boxes. This is reduced to only 7 man-minutes per 100 boxes if the boxes are palletized in the field and unloaded at the plant with a fork operations. The range in labor requirements runs from a low of 22 man-minutes per 100 boxes with Method F--the low-bed highway trailer--through an intermediate level of 35 man-minutes per 100 boxes with Method C--in which a truck of 216-box capacity is used on a direct haul from orchard row to plant--to a high of 75 man-minutes per 100 boxes with Method B--in which a flat-bed truck of 216-box capacity is used in combination with an orchard trailer. Contrasting these three methods, labor requirements are least with Method F, in which a one-man loading crew handles each box only once; they are at an intermediate level with Method C in which--with a two-man crew--each box is handled twice in loading; and labor requirements are highest with Method B, in which--with a two-man crew--each box is handled twice in loading the orchard trailer and rehandled in transferring [illegible]

The figures in column 5 of Table 12 also indicate a slight variation in labor required in the orchard as size of load varies. For example, with Method B the labor required in the orchard is 75 man-minutes per 100 boxes when the load size is 216 boxes and 72 man-minutes per 100 boxes when the load size is 320 boxes. This reduction in labor requirements for the larger load results from spreading the fixed time requirements, such as driving to the first load point and tying the load, over a larger number of boxes.

Grower's labor at plant

Estimates of the grower's labor required at the plant with different types of hauling equipment are given in column 6 of Table 12. These estimates range from 6 man-minutes per 100 boxes when a fork truck is used to unload a field palletized truckload of 320 boxes to 43 man-minutes per 100 boxes when a two-man grower crew--without assistance from the plant--unloads the boxes by hand from a pickup truck of 50-box capacity. With a given type of hauling equipment, the labor expended by the grower at the plant is reduced if the plant assists in hand stacking the boxes on skids or if the boxes are field palletized and unloaded at the plant with a fork truck. For example, when 216 boxes are hauled per load with Method B, the grower's at-plant labor is 37 man-minutes per 100 boxes if the boxes are stacked on pallets by a two-man grower crew without assistance from the plant. With the same equipment but with a one-man grower crew assisted by a plant receiver, the grower's at-plant labor is only 20 man-minutes per 100 boxes. This is reduced to only 7 man-minutes per 100 boxes if the boxes are palletized in the field and unloaded at the plant with a fork truck.[14] Similar variations are illustrated with other types of hauling equipment. These figures also indicate small reductions in the labor used by the grower at the plant as the size of load increases.

On-Highway Labor Requirements

The labor used per 100 boxes in travel on the highway between the orchard and the plant depends on the distance, the average road speed of the vehicle, the size of load, and the number of workers making the trip. Studies of hauling methods for apples and pears indicate an average highway speed for trucks of 17.7 miles per hour when loaded with full boxes and 20.5 miles per hour when carrying empty boxes. For tractor-drawn highway trailers, the corresponding rates were 12.4 and 16.7 miles per hour. These rates correspond to a round-trip time requirement for trucks of 6.32 minutes per mile of one-way distance between orchard and plant and for tractor-drawn trailers of 8.42 minutes per mile one-way distance. These data apply to farm-type vehicles operated over secondary roads under conditions comparable to those observed in transporting olives from orchard to plant. While considerable variation in rate of travel may be expected with different operators and with different road conditions, the above rates should approximate average conditions, and they have been used to estimate the "on-highway" labor requirements per 100 boxes per mile of one-way distance given in column 7 of Table 13. The estimates of on-highway labor are obtained by dividing the travel time per mile for the type of vehicle used by the load size in hundreds of lugs and then multiplying this figure by the number of workers making the trip. As indicated in the table, labor used in highway travel ranges from 2.0 man-minutes per 100 boxes--with the flat-bed truck hauling 320 boxes per trip with a one-man crew--to 21.1 man-minutes per 100 boxes--with the pickup truck hauling 60 boxes per trip with a two-man crew.

Total Labor Requirements

The total labor for loading and hauling expended by a grower using a particular method can be estimated from the data in columns 5, 6, and 7 of Table 13. Consider, for example, a grower who uses a pickup truck of 60-box capacity. At the plant, the boxes are stacked on skids by a two-man grower's crew. The one-way orchard-to-plant distance is five miles. Labor requirements for this method are given in the first line of Table 13. Summing the figures in columns 5 and 6,

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[14] For an analysis of labor and equipment requirements and costs incurred by the plant in the receiving operations, see page 51.

[illegible]

[illegible]

grower at the plant as the size of load increases.

Highway Labor Requirements

The labor used per 100 boxes in travel on the highway between the orchard and the plant depends on the distance, the average road speed of the vehicle, the size of load, and the number of workers making the trip. Studies of hauling methods for apples and pears indicate an average highway speed for trucks of 17.[illegible] miles per hour when loaded with full boxes and 20.[illegible] miles per hour when carrying empty boxes. For tractor-drawn highway trailers, the corresponding rates were 12.[illegible] and 16.7 miles per hour. These rates correspond to a round-trip time requirement for trucks of 6.[illegible]2 minutes per mile of one-way distance between orchard and plant and for tractor-drawn trailers of 8.42 minutes per mile of one-way distance. These data apply to farm-type vehicles operated over [illegible] vehicles from orchard to plant. While considerable variation in rate of travel may be expected with different operators and with different road conditions, the stated rates should approximate average conditions, and they have been used to estimate the "on-highway" labor requirements per 100 boxes per mile of one-way distance given in column 7 of Table 13. The estimates of on-highway labor are obtained by dividing the travel time per mile for the type of vehicle used by the load size in hundreds of boxes and then multiplying this figure by the number of workers making the trip. As indicated in the table, labor used in highway travel ranges from [illegible] man-minutes per 100 boxes--with the flat-bed [illegible] 100 boxes--with the pickup truck hauling 60 boxes per trip with a two-man crew.

Total Labor Requirements

The total labor for loading and hauling expended by a grower using a particular method can be estimated from the data in columns 5, 6, and 7 of Table 13. Consider, for example, a grower who uses a pickup truck of 60-box capacity. At the plant, the boxes are stacked on skids by a two-man grower's crew. The one-way orchard-to-plant distance is five miles. Labor requirements for this method are given in the first line of Table 13. Summing the figures in columns 5 and 6,

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1/ For an analysis of labor and equipment requirements and costs incurred by the plant in the receiving operation, see page [illegible].

the total labor required in the orchard and at the plant is 92 man-minutes per 100 boxes. Multiplying the figure given in column 7 for labor expended per mile one-way distance by five miles gives the on-highway labor; adding this figure to the previous sum gives a total labor requirement of 198 man-minutes per 100 boxes. Similar estimates can be made for other orchard-to-plant distances and for other methods. Such estimates for orchard-to-plant distances of one and five miles are summarized in columns 8 and 9 of the table.

Comparison of the estimated total labor requirements given in Table 13 for different methods indicates that substantial savings in labor may be possible through a change in procedure with a given method or by a change to a different method. Consider, for example, a grower located one mile from the plant who uses Method B--in which a highway truck of 216-box capacity is loaded at the roadside from an orchard trailer. The estimated labor requirements are 118 man-minutes per 100 boxes if the orchard-to-plant trip is made by a two-man crew. By changing to a one-man crew for the orchard-to-plant trip, labor requirements could be reduced to 98 man-minutes per 100 boxes--a saving of 20 man-minutes per 100 boxes.[15] If this change also involved palletizing the boxes at the roadside transfer point rather than at the plant, an additional saving of 13 man-minutes per 100 boxes would be possible.

Savings in labor also may be accomplished by a change to another method. Thus, the grower in the above example could save approximately 40 man-minutes per 100 boxes if he were to eliminate the transfer of boxes from orchard trailer to truck at the roadside by shifting to Method C--in which a highway truck is loaded directly in the orchard. Or, if the grower were to shift from his original method to Method E--using a two-unit, low-bed highway trailer of 216-box capacity--he could save 85 man-minutes per 100 boxes.

Effect of Equipment Costs on Choice of Method

The estimates of labor requirements with different methods given in Table 13 are useful guides in the selection of the most economical method, although additional factors must be considered. The most important of these is the type of equipment already available, the annual charges for new equipment that may be required in changing to a new method, and the amount of use the equipment will

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[15] The change from a two-man to a one-man crew for the orchard-to-plant haul may involve assistance from the plant receiver in hand stacking the boxes on skids or pallets unless the boxes are palletized in the field. Thus, this change, while reducing the grower's labor, may require an increase in plant labor.

receive per year. If only labor were considered, the high labor requirements with the pickup truck would suggest the choice of some other method. A small grower, however, who already has a pickup truck--which also is used for other purposes at other seasons--may find this method more economical than a different method requiring new equipment. On the other hand, a grower hauling a large quantity of fruit may find that a change to a different method may reduce labor costs by more than enough to pay for additional equipment. Unfortunately, it is not possible to give a simple answer to this question that will apply to all farm situations. Nearly all of the equipment used to haul fruit can be--and is--used for purposes other than fruit hauling. Trucks, tractors, and trailers have many farm uses, and their employment in fruit hauling may be relatively minor.

A study of economies resulting from the use of a particular piece of equipment in hauling fruit must include an analysis of all its applications and involves the allocation of the costs of the equipment to the different uses. Although no simple formula will fit all cases, a fairly reasonable solution may be possible for the individual grower. The grower knows what equipment he has available, what new equipment he would have to buy or build to use a particular method, and he can make some estimate of other uses for the new equipment on his farm. On the basis of this information and the transportation labor requirements discussed in this report, he should be able to make a reasonable selection of the most economical method.

The method of comparison may be illustrated by an example. Suppose that a grower located one mile from the plant now hauls fruit to the plant with a pickup truck of 60-box capacity using a one-man crew for the orchard-to-plant haul. He also owns a tractor but no trailer. He proposes to change to Method E using a single tractor-drawn trailer of 108-box capacity. Receiving methods at the plant will enable him to field palletize the boxes. Using the estimates of labor requirements given in Table 13, the saving in labor is (86-43) = 43 man-minutes per 100 boxes. If the labor cost is $1.00 per hour, this saving amounts to $0.72 per 100 boxes. In considering annual charges for the new equipment, other uses for the trailer are visualized that warrant charging only half the trailer cost to fruit hauling. Then, with a replacement cost for the trailer of $250, the portion allocated to fruit hauling is $125. With an annual equipment charge of 18 per cent of the original cost, the annual trailer costs allocated to [illegible] without requiring new equipment. On the other hand, a grower hauling a large quantity of fruit may find that a change to a different method may reduce labor costs by more than enough to pay for additional equipment. Unfortunately, it is not possible to give a simple answer to this question that will apply to all farm situations. Nearly all of the equipment used to haul fruit can be—and is—used for purposes other than fruit hauling. Trucks, tractors, and trailers have many farm uses, and their employment in fruit hauling may be relatively [illegible]

A study of economies resulting from the use of a particular piece of equipment in hauling fruit must include an analysis of all its applications and involves the allocation of the costs of the equipment to the different uses. Although no simple formula will fit all cases, a fairly reasonable solution may be possible for the individual grower. The grower knows what equipment he has available, what new equipment he would have to buy or build to use a particular method, and he can make some estimate of other uses for the new equipment on his farm. On the basis of this information and the transportation labor requirements discussed in this report, he should be able to make a reasonable selection of the [illegible]

The method of comparison may be illustrated by an example. Suppose that a grower located one mile from the plant now hauls fruit to the plant with a [illegible] haul. He also owns a tractor but no trailer. He proposes to change to Method E [illegible] the plant will enable him to field palletize the boxes. Using the estimates of labor requirements given in Table 13, the saving in labor is (86-43) = 43 man-minutes per 100 boxes. If the labor cost is $1.00 per hour, this saving amounts to $0.72 per 100 boxes. In considering annual charges for the new equipment, other uses for the trailer are visualized that warrant charging only half the trailer cost to fruit hauling. Then, with a replacement cost for the trailer of $250, the portion allocated to fruit hauling is $125; with an annual [illegible] charge of 12 per cent of the original cost, the annual trailer cost to [illegible] fruit hauling are $22.[16] To "break even" with costs under the old system, the saving in labor would have to total $22 or more per year. With an estimated laborsaving of $0.72 per 100 boxes, a total of (22/0.72) 100 = 3,050 boxes must be hauled per year to "break even." If a larger number were hauled per year, the new method would appear to be an economical choice for this grower.

PLANT STUDIES

The basic operations in receiving and grading were the same in all the plants studied. Fruit is delivered at the plant by the grower. A delivery receipt is written, the full boxes of fruit are unloaded and transported to a temporary storage, and the grower's truck is reloaded with empty boxes. The incoming fruit is later transported to a dumping station where the contents are emptied on a conveyor leading to a sorting table and grader. Cull fruit is sorted out manually and the fruit is sized mechanically. The sized fruit is collected, weighed, and then transported to the vat room where it is dumped into tanks for storage and processing.

While the basic operations are the same in all plants, there are important differences between plants in the type of equipment and in methods used to perform some of the operations. Other factors also vary, such as the proportion of nonproductive time resulting from delays and from breaks between lots of different growers.[17] The extent to which such variations between plants may affect labor costs is indicated in Table 14 which shows that, with a uniform schedule of wages for all plants, direct labor costs in eight plants studied ranged from $1.73 to $3.69 per 1,000 pounds of fruit run.[18]

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[16] The percentage of replacement costs to be charged each year includes the following: depreciation, 10 per cent; repairs, 3.0 per cent; insurance, 1.0 per cent; taxes, 1.0 per cent; interest, 3.0 per cent (approximately equivalent to 5.0 per cent of the undepreciated balance); total, 18.0 per cent.

[17] See page 21 for a discussion of break-for-lots and sample grading procedures for accounting to growers for fruit delivered.

[18] Average direct labor cost per 1,000 pounds was obtained by computing the hourly payroll cost--using uniform wage schedules considered typical of all the plants studied--then dividing this figure by the volume run per hour. The volume run per hour is the average rate per hour for the period of the study in each plant, amounting to one-half to two days per plant. The rates thus obtained will differ from average season rates which presumably would reflect wider variations in crew organization and volume run per hour than were observed in the study. For the wage schedule used, see Appendix A.

[illegible] be held [illegible] prior to "break over." If a Bartlett [illegible] were handled this way, the new method would appear to be of economical value for this area.

[illegible]

The basic operations in receiving and grading are the same in all the plants studied. Fruit is delivered at the plant by the grower. A delivery receipt is written, the full boxes of fruit are unloaded and transferred to a temporary storage, and the grower's truck is reloaded with empty boxes. The incoming fruit is later transported to a dumping station where the contents are emptied on a conveyor leading to a sorting table and grader. Cull fruit is sorted out manually and the fruit is sized mechanically. The sized fruit is collected, weighed, and then transported to the wet room where [illegible]

While the basic operations are the same in all plants, there are important differences between plants in the type of equipment and in methods used to perform some of the operations. Other factors also vary, such as the proportion of nonproductive time resulting from delays and from breaks between lots of [illegible].[11] [illegible] The effect of these differences on labor costs is indicated in Table 11 which shows that, with a uniform schedule of wages for all plants, direct labor costs in eight plants studied ranged from [illegible] to [illegible] per 1,000 pounds of fruit.[12]

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[10] The percentages of replacement costs to be charged each year includes the following: depreciation, 10 per cent; repairs, 5.0 per cent; insurance, 1.0 per cent; taxes, 1.0 per cent; interest, [illegible] per cent (approximately equivalent to 6.0 per cent of the undepreciated balance); total, [illegible] per cent.

[11] See page 21 for a discussion of [illegible] and sample grading procedures for accounting to growers for fruit deliveries.

[12] [illegible] studied—then dividing this figure by the volume handled per hour. The [illegible] per hour is the average rate per hour for the period of the study [illegible] amounting to one-half to two days per plant. The rates thus [illegible] from average season rates which presumably would reflect [illegible] in crew organization and volume handled that were observed in the study. For the wage schedule used, see Appendix [illegible]

TABLE 14

Observed Plant Labor Costs for the
Receiving and Initial Processing of
Sevillano Olives, Corning Area, 1952

Plant	Plant volume	Labor cost[a]
	1,000 pounds per hour	dollars per 1,000 pounds
I	3.1	3.69
II	13.3	1.87
III	10.0	2.87
IV	11.8	1.78
V	10.5	2.40
VI	7.2	2.50
VIII	5.2	3.35
IX	12.3	1.73

a/ Based on a uniform schedule of wages for all plants. See Table C, Appendix A for wage schedule used.

The purpose in this section is to show how the relative costs and efficiency of performing the receiving and grading operations vary with different types of equipment and methods. To do so it is necessary to compute costs for the various methods when they are used in standardized situations and to include in the cost comparisons estimates of the annual fixed charges and operating costs for equipment. In making these estimates, crew and equipment requirements and costs are based on standardized production and cost rates derived from studies of actual plant operations. These cost and production rates are applied to operations which are considered representative of efficient--although not "ideal"--plant organization. While the resulting estimates are likely to differ from those applicable to any particular plant, they should be representative of efficient levels of operation and should indicate reasonably well the relative costs with different types of equipment and work methods.

Two cost categories are recognized in making these estimates. One includes all direct costs, such as labor, electric power, gasoline, and repair costs directly attributable to use. The second category consists of the annual fixed charges for equipment and includes depreciation, interest, taxes, insurance, and "fixed" repair expenses.

In the following discussion, estimates of direct and fixed costs are presented for six different methods of receiving and dumping incoming fruit and for four different methods of collecting and transporting graded fruit. Data also are presented on the costs observed for the sorting and weighing operations and for supervision. These costs for separate operations are then combined to obtain cost estimates for the entire grading and receiving process, using several different combinations of the methods employed for particular operations. The various cost estimates are presented in summary form in the following sections. Some details of the procedures used in the analysis are given in Appendix A.

Receiving and Dumping Incoming Fruit

Six different methods of receiving and dumping incoming fruit are considered in the discussion that follows. With all of these methods, the operations include writing the grower's receipt, unloading full field boxes from the grower's truck, transporting the field boxes to a temporary storage and later to a dumping station, dumping the fruit, transporting the empty boxes to the grower's truck via a temporary storage, and finally reloading the grower's truck with empty boxes.

Two of the methods used to perform these operations require that the field boxes be transferred by hand from the grower's truck to skids or pallets, with transportation within the plant performed with hand skid-trucks or fork trucks. With the other methods, the field boxes are moved directly from the grower's truck with hand trucks or fork trucks or by conveyor. Of the six methods discussed below, only three--those involving the use of the hand skid-truck or fork truck--were observed in the plant studies. The remaining methods represent a synthesis of procedures that might be practicable and for which measurements of labor requirements are available for use in estimating costs.

Hand Skid-Truck--Method A

With this method, field boxes are transferred by hand to a skid of 30-to-40-box capacity, and the skid loads of fruit are transported within the plant with

a hand skid-truck[19] The jobs involved in the receiving and dumping operations are as follows.

Stack Boxes on Skids: Incoming boxes are hand transferred by the grower to the receiving dock of the plant or to the edge of the truck. A plant receiver stacks the boxes on a skid.[20] A similar procedure is followed in reloading the grower's truck with empty boxes.

Move Skid: Skid loads of full boxes are moved with a hand skid-truck to a temporary storage and then to a dumper. Similarly, empty boxes are moved from the dumper to a temporary storage and then to the grower's truck.

Dump Field Boxes: Boxes are lifted by hand from the skid and the contents are emptied in a dumping hopper. The empty box is stacked on an empty box skid.

Fork Truck--Method B

The procedure with this method is the same as with Method A, except that the boxes are stacked on pallets instead of on skids, and the transportation of fruit and boxes within the plant is by fork truck.

Fork Truck--Method C

With this method, the procedure is the same as with Method B, except that the boxes are palletized in the field, and the pallet loads of fruit are unloaded at the plant directly with a fork truck, thus eliminating the hand stacking of boxes at the plant.

Hand Truck--Method D

With this method, a side clamp hand truck is used to move stacks of full boxes from the grower's truck and to reload empty boxes.[21] Incoming fruit is

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[19] The net weight per box varied from 32 to 50 pounds, usually averaging 40 pounds per box.

[20] In some instances, the entire stacking operation was performed by the grower, but for purposes of comparison, it is assumed that this operation is performed jointly by the grower and plant receiver except in the very small plants. Only the labor cost of the plant worker is included in the cost estimates.

[21] Note that the hand-truck method requires the highway truck bed to be at the same level as the plant floor. In some plants this would require structural changes, the costs of which would have to be considered in evaluating this method.

transported to a temporary storage and then to a dumper. Empty boxes are returned to the grower's truck via a temporary storage. All of these operations are performed by plant workers with assistance from the grower only to the extent of separating stacks of boxes on the truck sufficiently to permit use of the side clamp hand truck.

Direct Unload with Conveyor--Methods E and F

The conveyor method is designed to eliminate the hand box-stacking operations required with Methods A and B and to minimize the trucking required within the plant. This method was not observed in any of the plants studied, but the work methods and labor and equipment requirements have been "synthesized" from production rates determined from studies of comparable jobs in fruit packing houses.[22/] The arrangement visualized requires a system of conveyors by means of which incoming boxes of fruit are set off directly from the grower's truck to a conveyor leading to a dumping station. The fruit is dumped into a bin, and the empty boxes are placed on a second conveyor leading to an empty box storage area. In the empty box storage area, the boxes are nested in groups of four boxes, and the nested boxes continue on a gravity conveyor leading to a loading point for the grower's truck.[23/] When the storage capacity of this conveyor is exceeded, the nested boxes are set off and transported to temporary storage.

In the estimates of costs for this method, it is assumed that full boxes are set on the conveyor to the dumper by the grower and that the grower also reloads his truck with empty boxes. These jobs, therefore, are omitted from the estimates of plant costs, leaving only the costs of the dumping and box-nesting operations and the costs of equipment.

Two variations of the conveyor method are considered. In one--Method E--all the incoming fruit is dumped into an oversized hopper--the hopper having capacity for about one-half hour of plant operation. In the other--Method F--the incoming fruit may go directly to the sorting table or may be diverted to storage bins with capacity for four hours of plant operation. These bins are provided

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[22/] The conveyor method of receiving combined with mechanical dumping of the field boxes is used in plants in the Lindsay area. The short harvesting season prevented study of these operations.

[23/] The purpose in nesting the boxes would be to increase the storage capacity of the empty-box conveyor leading to the grower's truck. In some cases, the dimensions of the boxes used would not permit nesting; in other cases, removal of the longitudinal cleats frequently used on the boxes would be required.

[illegible] of separating stacks of boxes on the truck sufficiently to permit use of the [illegible] hand truck.

[illegible]—Methods E and F

The conveyor method is designed to eliminate the hand box-stacking operations required with Methods A and B and to minimize the trucking required within the plant. This method was not observed in any of the plants studied, but the work methods and labor and equipment requirements have been "synthesized" from production rates determined from studies of comparable jobs in fruit packing houses.[22] The arrangement visualized requires a system of conveyors by means of which incoming boxes of fruit are set off directly from the grower's truck to a conveyor leading to a dumping station. The fruit is dumped into bins, and the empty boxes are placed on a second conveyor leading to an empty box storage area. In the empty box storage area, the boxes are nested in groups of four boxes, and the nested boxes continue on a gravity conveyor leading to a loading point for the grower's truck.[23] When the storage capacity of this conveyor is exceeded, the nested boxes are set off and transferred to temporary storage.

In the estimates of costs for this method, it is assumed that full boxes are set on the conveyor to the dumper by the grower and that the grower also loads his truck with empty boxes. These jobs, therefore, are omitted from the estimates of plant costs, leaving only the costs of the dumping and box-nesting operations and the costs of equipment.

Two variations of the conveyor method are considered. In one—Method E—all [illegible] for about one-half hour of plant operation. In the other—Method F—the incoming fruit may go directly to the sorting table or may be diverted to storage bins with capacity for four hours of plant operation. These bins are provided with a bin-dumping and conveyor system by which the stored fruit may be brought to the sorting table without rehandling.[24] Bin storage space is provided at the rate of 270 cubic feet per 1,000 pounds of fruit stored.

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[22] The conveyor method of receiving combined with mechanical dumping of the [illegible] boxes is used in plants in the [illegible] area. The chart [illegible] study of these operations.

[23] [illegible]

Comparison of Receiving and Dumping Costs with Different Methods

Costs with the receiving and dumping methods outlined above are compared in Table 15. In this table, total costs per season are given for rates of operation of 5,000, 10,000 and 15,000 pounds of fruit per hour and for seasons of 150 and 300 hours in length. Two categories of costs are included. These are direct costs for such items as labor, electric power, gasoline, and fixed costs for equipment including the costs of insurance, interest on the investment, taxes, "fixed" repair expense, and depreciation.

TABLE 15

Total Costs Per Season for Receiving and Dumping Sevillano Olives with Six Different Arrangements as to Equipment and Work Methods, Corning Area, 1952[a]

Method	Volume					
	5,000 pounds per hour		10,000 pounds per hour		15,000 pounds per hour	
	150 hours	300 hours	150 hours	300 hours	150 hours	300 hours
	dollars per season					
A. Hand skid-truck	550	1,100	950	1,800	1,350	2,550
Fork truck						
B. Boxes palletized at plant	600	950	1,050	1,750	1,500	2,550
C. Boxes palletized in field	450	750	900	1,500	1,400	2,200
D. Hand truck	400	850	750	1,450	1,050	2,050
Conveyor						
E. Direct to dumper	450	750	600	1,000	750	1,200
F. Four-hour storage	1,000	1,450	1,500	2,000	2,000	2,600

[a] The cost estimates are based on production rates for the various jobs, cost rates for labor, and cost rates for equipment typical of the Corning area in 1952. See Appendix A for details.

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[24] With storage of olives in bins to a depth of 3 or 4 feet, some heating could occur which could cause damage to the fruit, particularly if the storage period were prolonged. As this method has not been observed in operation, this question cannot be answered on the basis of actual experience. It is likely, however, that, if such difficulty arose, it could be taken care of by a simple and inexpensive bin ventilation system.

Relative costs with the different methods can be shown by comparison of the costs given in Table 15. For example, with a rate of operation of 10,000 pounds per hour and 150 hours of operation per season, the costs range from $600 per season with Method E to $1,500 per season with Method F. As both methods involve the use of a conveyor system for unloading the grower's truck, the difference in cost represents the additional costs of the storage bin and fruit conveyor system required with Method F. Little difference is shown in the costs with hand skid-trucks and fork trucks--Methods A, B, and C. All of these methods are slightly higher in cost than Method D in which the grower's trucks are unloaded with hand trucks. Savings which might be achieved with the fork-truck method through palletizing boxes in the field are partially offset by the increase in fixed costs due to the addition of field pallets to the equipment requirements.25/ For this reason, the savings possible through changing from Method B to Method C are relatively small.

In Method E, the incoming field boxes are set off on a conveyor to the dumper with storage capacity for only one-half hour of plant operation. This arrangement would require close scheduling of deliveries from the orchards in order to assure efficient plant operation. In some plants, such scheduling problems might require the provision of greater storage capacity--as in Method F--or require trucking a portion of the incoming fruit to a temporary floor storage in order to provide a reserve supply. Either change in procedure would result in costs with Method E at a higher level.

Collect Graded Fruit and Transport to Pickling Tanks

The operations in this part of the receiving and grading process consist of collecting the size-graded fruit in boxes or portable bins, transporting it to a scale and from the scale to the pickling tanks, dumping the fruit into the tanks, and returning the empty boxes or bins to the grader room. The fruit may be dumped into low-sided rectangular tanks or into cylindrical wood-stave vats 6 to 10 feet high. The boxes are transported with handcarts, and the bins are transported with fork trucks.

25/ The costs with Method C include fixed costs for pallets amounting to $70 per year with a rate of operation of 5,000 pounds per hour; $140 per year with a rate of operation of 10,000 pounds per hour; and $210 per year with a rate of operation of 15,000 pounds per hour. These costs might be reduced substantially if pallets normally used for warehousing canned olives could be used as field pallets.

[illegible]

[illegible]

[illegible]

[illegible]

volve the use of a conveyor system for unloading the grower's truck; the differ-
ence in cost represents the additional costs of the storage bin and fruit [illegible]
[illegible]
hand skid-trucks and fork trucks—Methods 4, 5, and 6. All of these methods are
[illegible]
with hand trucks. Savings which might be achieved with the fork-truck method
through palletizing boxes in the field are partially offset by the increase in
fixed costs due to the addition of field pallets to the equipment requirements
[illegible]
are relatively small.

In Method 7, the incoming field boxes are set off on a conveyor to the
[illegible]
arrangement would require close scheduling of deliveries from the orchards in
order to assure efficient plant operation. In some plants, such scheduling
problems might require the provision of greater storage capacity—as in Method 8—
or require trucking a portion of the incoming fruit to a temporary floor storage
[illegible]
in costs with Method 8 at a higher level.

[illegible]

The operations in this part of the receiving and [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
8 to 10 feet high. The boxes are transported with handtrucks, and the bins are
[illegible]

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[illegible]

Box and Handcart

With this method, the graded fruit is collected in boxes, the boxes are transported on handcarts, and the fruit is emptied into the brine tanks by hand. The jobs involved in this process are as follows.

Collect Fruit in Boxes: Graded fruit is collected in boxes placed under the sized fruit chutes of the grading machine. Full boxes are set off to a handcart or skid by size category. At the end of each lot--or as the carts are filled with boxes--the carts are moved to the scale for weighing.

Cartmen: In this operation, cartloads of boxes are moved from the scale to the vat room and empty lugs are returned. The typical load is 12 boxes of 36 pounds net weight per box. Labor requirements are estimated in relation to the distance transported, and this varies with the size of plant.[26]

Dump Boxes of Graded Fruit: Full boxes of fruit are lifted individually from the cart, and the contents are dumped into a low-sided tank or a high-sided vat. Empty boxes are restacked on the cart. Fruit may be dumped in the low-sided tanks by one man working alone, but dumping fruit into the high-sided vats requires a two-man dumping "team."

Portable Bins and Fork Truck--Methods I and J

With these methods, the containers used in transporting graded fruit consist of portable bins which are mounted on caster wheels so that they can be moved by hand for short distances. Relatively long movements are made with fork trucks. Two types of bins are considered. One type--referred to below as Method I--is a 600-pound-capacity bin. The second type--designated as Method J--is a 1,200-pound-capacity bin. The procedures for the various jobs are as follows.

Collect Fruit in Bins: This job consists of moving the portable bins between the grader and the scale and placing empty bins at the grader as the bins become full.

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[26] Reasonable estimates of transportation distance in relation to plant size appear to be an average one-way distance of 125 feet per trip in plants of 5,000 pounds per hour capacity and 200 feet in plants of 10,000 pounds per hour capacity. Labor requirements are scaled to this degree of variation in transport distance.

[illegible]

[illegible] method, the graded fruit is collected in boxes, the boxes are transported on handcarts, and the fruit is emptied into the brine tanks by [illegible].

Collect fruit in boxes: Graded fruit is collected in boxes placed [illegible]. The boxes are set out to a handcart or held by size category. At the end of each [illegible]--or as the carts are filled with boxes--the carts are moved to the scale for weighing.

[illegible]: In this operation, cartloads of boxes are moved from the scale to the vat room and empty boxes are returned. The typical load is 12 boxes of 35 pounds net weight per box. Labor requirements are estimated in relation to the distance transported, and thus varies [illegible].[10]

Dump Boxes of Graded Fruit: Each box of fruit is lifted individually from the cart, and the contents are dumped into a low-sided tank or a high-sided vat. Empty boxes are restacked on the cart. Fruit may be dumped in the low-sided tanks by one man working alone, but dumping fruit into the high-sided vats requires a two-man dumping [illegible].

[illegible]

[illegible], as developed and used in [illegible], graded fruit [illegible] of portable bins which are mounted on caster wheels so that they can be moved by hand for short distances. Relatively long movements are made with fork trucks. Two types of bins are considered. One type--referred to below as Method 2--is a [illegible]. The second type [illegible] a [illegible]-pound capacity bin. The procedures for the various jobs are as follows.

Collect fruit in bins: This job consists of moving the portable bins between the grader and the scale and placing empty bins at the grader as the bins become full.

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[10] Reasonable estimates of transportation distance in relation to [illegible] to be an average one-way distance of 125 feet per trip in plants of 2,000 pounds per hour capacity and 200 feet in plants of 12,000 pounds per hour capacity. Labor requirements are scaled to this degree of [illegible].

Truck and Dump Bins: This work includes transporting the bins between the tanks or vats and the grader room and dumping the fruit into the brine. With either the 600-pound- or 1,200-pound-capacity bin, the dumping operation can be performed by the fork-truck operator. (The 600-pound bins are pivoted on an attachment to the fork truck, and the bin is emptied by rotating it on the pivot. The 1,200-pound bins have a gate which can be opened by the fork-truck operator to empty the bin.)

Comparison of Costs of Handling Graded Fruit

Total costs per season for handling graded fruit with the above methods are summarized in Table 16 for three different rates of plant operation and for seasons of 150 and 300 hours of operation. With 150 hours of operation per season, the handcart method of dumping into the low-sided tanks is lowest in cost but, if the fruit is dumped into the high-sided vats, costs with either of the fork-truck methods are lower than with handcarts. In most plants, both types of tanks may be used, and costs with the handcart method would lie between the level of costs indicated for the low-sided tanks and the high-sided vats. As the length of season increases, the methods using laborsaving equipment--but having high fixed costs--become more advantageous. This is evident in contrasting costs with seasons of 150 and 300 hours of operation and a given rate of operation per hour.

Sorting

The sorting operation consists primarily of removing cull fruit, breaking up clusters of fruit, and in some plants removing stems if the stems are not removed mechanically.[27] The labor requirements thus depend on the type of equipment used, the condition of the fruit, and the policy followed by the plant in regard to the quality of sorting desired and the amount of resorting to be done prior to the final processing. In the plants studied, the sorting labor ranged from 0.64 to 1.43 hours per 1,000 pounds of fruit run and averaged 1.04 hours per 1,000 pounds. The studies indicate that for average conditions a minimum crew consists of four sorters and that this crew is adequate for rates

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[27] Several plants used mechanical stemmers, and this presumably would affect the sorting labor requirements. Insufficient data are available, however, to indicate the extent of this effect.

[illegible] [illegible]. This type [illegible] [illegible] the [illegible] [illegible] the fruit [illegible] the [illegible] [illegible] [illegible] [illegible] and [illegible]. With either the 600-pound or 1,000-pound-capacity bins, the dumping operation can be performed by the fork-truck operator. (The 600-pound bins are pivoted on an attachment to the fork truck, and the bin is emptied by rotating it on the pivot. The 1,000-pound bins have a gate which can be opened by the fork-truck operator to empty the bin.)

[illegible]

Total costs per season for handling graded fruit with the above methods are summarized in table [illegible] for three different rates of plant operation and for seasons of 150 and 300 hours of operation. With 150 hours of operation per season, the handcart method of dumping into the low-sided tanks is lowest in cost but, if the fruit is dumped into the high-sided vats, costs with either of the fork-truck methods are lower than with handcarts. In most plants, both types of tanks may be used, and costs with the handcart method would lie between the level of costs indicated for the low-sided tanks and the high-sided vats. As the length of season increases, the methods using labor-saving equipment—having high fixed costs—become more advantageous. This is evident in contrasting costs with seasons of 150 and 300 hours of operation and a given rate of [illegible].

[illegible]

[illegible] up clusters of fruit, and in some plants removing stems if the stems are not removed mechanically.[27] The labor requirements thus depend on the type of equipment used, the condition of the fruit, and the policy followed by the plant in regard to the quality of sorting desired and the amount of re-sorting to be done prior to the final trimming. In the plants studied, the sorting labor ranged from 0.64 to 1.43 hours per 1,000 pounds of fruit run and averaged 1.01 hours per 1,000 pounds. The records indicate that for average conditions a minimum crew consists of four sorters and that this crew is adequate for rates

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[27] Several plants used mechanical stemmers, and this probably [illegible] their sorting labor requirements. Insufficient data are available, however, to [illegible] [illegible] of this [illegible].

TABLE 16

Total Costs per Season for Handling Graded Olives Between Sizer and Brine Tanks with Four Different Arrangements as to Equipment and Work Methods, Corning Area, 1952[a]

Method	Volume					
	5,000 pounds per hour		10,000 pounds per hour		15,000 pounds per hour	
	150 hours	300 hours	150 hours	300 hours	150 hours	300 hours
	dollars per season					
G. Handcart to high-sided vat	1,150	2,050	1,900	3,650	2,650	5,250
H. Handcart to low-sided tank	700	1,350	1,200	2,400	1,700	3,350
I. Fork truck to tanks or vats (600-pound-capacity bin)	900	1,300	1,500	2,250	1,950	3,200
J. Fork truck to tanks or vats (1,200-pound-capacity bin)	750	1,100	1,350	2,000	1,900	2,800

[a] The cost estimates are based on production rates for the various jobs and on cost rates for labor and equipment typical of the Corning area in 1952. See Appendix A for details.

of operation less than 5,000 pounds per hour. For higher rates of operation, two additional sorters are required for each 5,000-pound increase in the volume of fruit run per hour. Labor requirements estimated on this basis and estimates of direct costs and fixed costs for the sorting operation are summarized in Table 17.

TABLE 17

Total Cost per Season for Sorting Sevillano Olives, Corning Area, 1952[a]

Rate per hour	Hours per season	
	150	300
1,000 pounds	dollars per season	
5	740	1,410
10	1,080	2,080
15	1,430	2,760
20	1,770	3,430
25	2,110	4,100

[a] The cost estimates are based on production and cost rates for labor and equipment typical of the Corning area in 1952. See Appendix A for details

Weigh Graded Fruit and Plant Supervision

In plants in which accounting to the grower is based on a separate-lots system, each lot of graded fruit must be weighed and a record prepared of the quantity of fruit in the various grades. The plant studies indicate that, under typical conditions, one weighman can perform these operations for volumes not exceeding approximately 17,000 pounds per hour. In some of the small plants, the weighing job was combined with the supervisory responsibilities, but for rates of operation exceeding about 7,500 pounds per hour, separate workers were assigned to each job.

Total Receiving and Grading Costs

Using the estimates given above for costs in the various stages of plant operation, it is possible to develop estimates of costs for the entire receiving and grading process. As there are several variations in method for the receiving and dumping of incoming fruit and for the handling of graded fruit, the estimated costs for the entire operation will depend on the combination of methods used. Estimates of total season costs are given for eight different plant "designs" in Table 18. These costs are composed of direct costs for such items as labor and power and fixed costs for all equipment required in the receiving and grading operations, including the costs of sizing equipment and floor scales. Annual fixed costs for the building are not included nor are indirect costs such as office clerical expenses and management costs other than direct supervision of the receiving and grading operations.

These estimates represent expected costs in different types of plants designed for operation under standardized conditions except for specified variations in equipment and work methods. They should reflect reasonably well the relative costs when the various plant operations are performed in different types of plants at comparable levels of efficiency. However, the costs indicated with a given type of plant may not compare closely with an actual plant of that type if operating conditions differ markedly from the conditions typical of efficient--though not optimum--operations on which the estimates are based.

The costs given in Table 18 are for average rates of plant operation of 5,000, 10,000, and 15,000 pounds per hour and for seasons of 150 and 300 hours in length. Hours of plant operation per season have an important effect on relative costs with different methods. For example, with a rate of plant operation of 10,000 pounds per hour, the total season costs are $4,800 with Plant 3 and $4,900 with Plant 7. With 300 hours of operation per season, however, season

Weighing and Record Preparation

In plants in which accounting to the grower is based on a weight--lots basis, each lot of graded fruit must be weighed and a record prepared of the quantity of fruit in the various grades. The plant studies indicate that, under typical conditions, one weighman can perform these operations for volumes not exceeding approximately 12,000 pounds per hour. In some of the small plants, the weighing job was combined with the supervisory responsibilities, but for rates of operation exceeding about 7,500 pounds per hour, separate workers were assigned to each job.

Total Receiving and Grading Costs

Using the estimates given above for costs in the various stages of plant operation, it is possible to develop estimates of costs for the entire receiving and grading process. As there are several variations in method for the receiving and dumping of incoming fruit and for the handling of graded fruit, the estimated costs for the entire operation will depend on the combination of methods used. Estimates of total season costs are given for eight different plant "designs" in Table 18. These costs are composed of direct costs for such items as labor and power and fixed costs for all equipment required in the receiving and grading operations, including the costs of sizing equipment and floor scales. Annual fixed costs for the building are not included nor are indirect costs such as [illegible] the receiving and grading operations.

These estimates represent expected costs in different types of plants de- [illegible] ing equipment and work methods. They should reflect reasonably well the relative costs when the various plant operations are performed in different types of plants at comparable levels of efficiency. However, the costs indicated with a given type of plant may not compare closely with actual costs of that type if operating conditions differ markedly from the conditions typical of efficient--though not optimum--operations on which the estimates are based.

The costs given in Table 18 are for average rates of plant operation of 5,000, 10,000, and 15,000 pounds per hour and for seasons of 150 and 300 hours in length. Hours of plant operation per season have an important effect on relative costs with different methods. For example, with a rate of plant operation of 10,000 pounds per hour, the total season costs are $4,300 with Plant 3 and $4,910 with Plant 7. With 300 hours of operation per season, however, season total costs with Plant 3 are $8,400 in contrast with only $7,600 in Plant 7. This shift results because the relatively high annual fixed costs for equipment with Plant 7--in which direct costs are relatively low--are spread over more hours of operation with the longer season. The data also indicate that relative costs with different methods are affected to some extent by the rate of plant operation per hour. This effect is most noticeable with Plants 7 and 8 in which costs relative to the other types of plants decrease as the rate of operation per hour increases.

TABLE 18

Total Costs per Season for the Receiving and Initial Processing of Sevillano Olives with Eight Different Types of Plant Organization, Corning Area, 1952[a]

	Volume					
	5,000 pounds per hour		10,000 pounds per hour		15,000 pounds per hour	
Type of plant	150 hours	300 hours	150 hours	300 hours	150 hours	300 hours
	dollars per season					
Hand skid-truck and handcart						
1. Graded fruit dumped in low-sided tanks	3,200	5,400	5,100	8,600	6,900	11,900
2. Graded fruit dumped in high-sided vats	3,500	6,100	5,700	9,900	7,900	13,800
Hand truck and handcart						
3. Graded fruit dumped in tanks	3,100	5,300	4,800	8,400	6,600	11,400
4. Graded fruit dumped in vats	3,400	6,000	5,600	9,700	7,700	13,400
Fork truck						
5. Boxes plant palletized, 600-pound bin for graded fruit	3,500	5,500	5,600	8,700	7,600	11,800
6. Boxes field palletized, 1,200-pound bin for graded fruit	3,200	5,000	5,200	8,000	7,200	11,000
Conveyor receiving, 1,200-pound bin for graded fruit						
7. One-half hour storage for incoming fruit	3,300	5,200	4,900	7,600	6,500	10,000
8. Four-hour storage for incoming fruit	3,700	5,900	5,800	8,700	7,800	11,500

[a] The cost estimates are based on production rates for the various jobs and on cost rates for labor and equipment typical of the Corning area in 1952. See Appendix A for additional details.

The relative costs with different methods are shown graphically in Figure 7 which gives total season costs with the different types of plants in relation to hours of operation per season. With 100 hours of operation, for example, the lowest cost occurs with Plant 3--in which hand trucks and handcarts are used with the graded fruit dumped into low-sided tanks. The high-cost plant is number 8 in which the graded fruit is handled with fork trucks and incoming fruit is unloaded by conveyor with provision for storage of the fruit prior to grading. With 200 hours of operation per season, plant number 7 is lowest in total season cost, and plant number 2 is the high-cost plant.

Figure 7 also shows how the type of brine tank used for graded fruit may affect the choice of materials handling equipment. With 200 hours of operation per season, for example, total season costs are higher in Plant 2--a handcart plant in which the graded fruit is placed in the high-sided vats--than in the fork-truck plants, numbers 5 and 6. However, if all of the graded fruit in the handcart plant is placed in low-sided tanks--as in plant number 1--total season costs are less than in fork-truck plant number 5 and about equal to the season costs in fork-truck plant number 6. This indicates that the choice of most economical equipment may depend on the type of processing equipment used in stages of plant operation other than the receiving and grading operations.

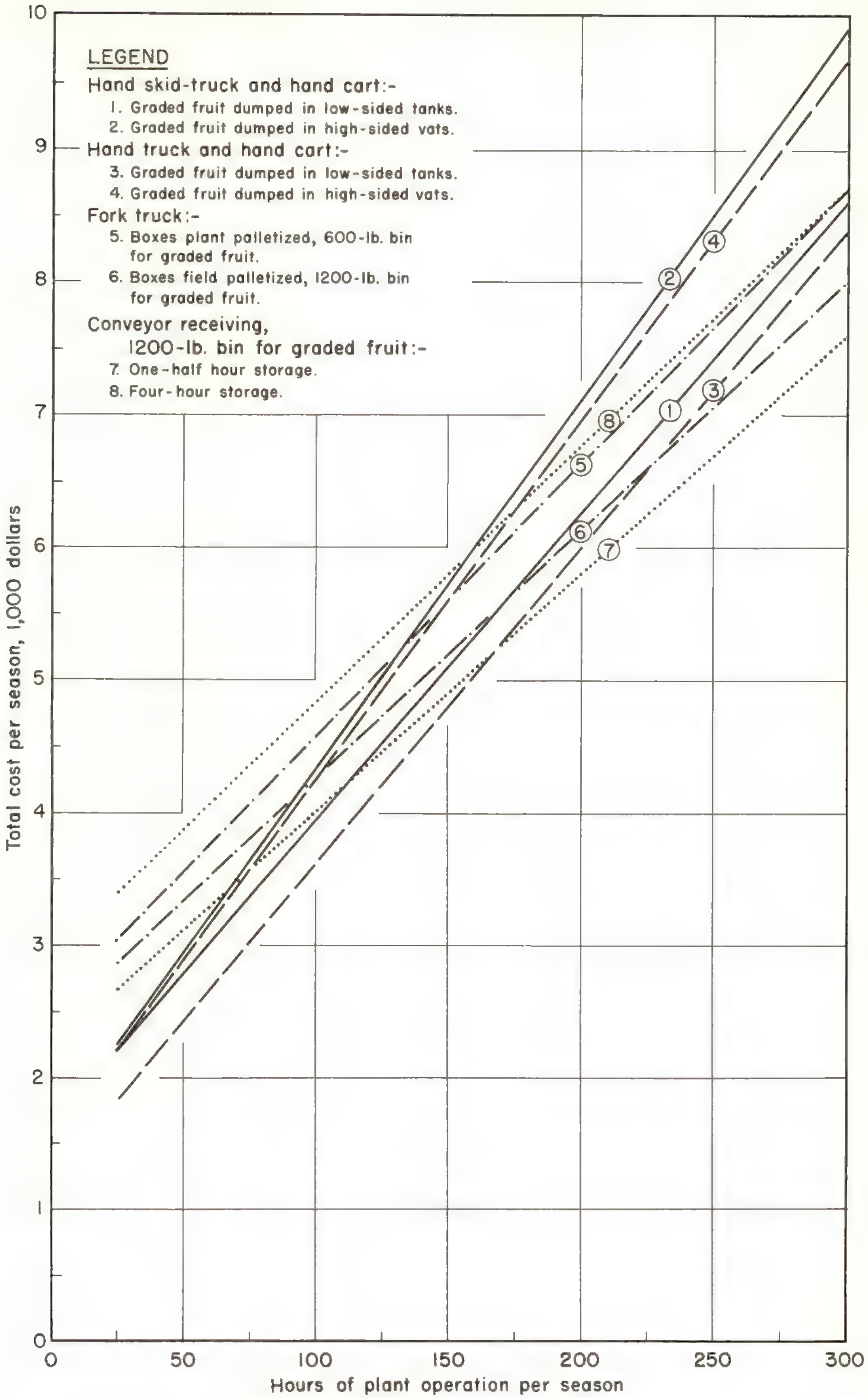

FIGURE 7. TOTAL COST PER SEASON FOR RECEIVING AND INITIAL PROCESSING OF SEVILLANO OLIVES WITH EIGHT DIFFERENT TYPES OF PLANT. (RATE OF PLANT OPERATION, 10,000 POUNDS OF FRUIT PER HOUR.)

SUMMARY

Under the price and cost conditions existing during the 1952 season, the production of Sevillano olives was not as profitable as it has been in some past seasons. Factors affecting the costs of picking, assembling, and grading Sevillano olives are summarized in this report.

Pickling for consumption as ripe or green olives is the principal outlet for California olives. Under present marketing restrictions, only the four grades of giant through supercolossal can be canned as ripe olives. Prices paid to growers are much higher for these sizes than for the smaller noncanning sizes.

The grower can increase the proportion of his crop in canning sizes and the total tonnage by not picking too early. Increases in value of fruit due to gain in weight and size will be partly offset by an increase in the percentage of fruit falling into culls because of overripeness, but this would normally be small relative to the potential gains. The loss to culls could be reduced by a double picking to remove the mature fruit from tops of trees and border rows two to three weeks ahead of the final picking. Whether the double picking would be profitable depends on the relationship between olive prices and picking costs.

The total tonnage of fruit for which a grower is paid can be increased by minimizing the shrinkage in weight and size which occurs between the time that the fruit is picked and the time that it is graded. Tests conducted during 1952 showed that fruit lost more in weight, size, and grade when stored in the orchard than it did when stored in the processing plant prior to grading. The percentage of olives grading culls because of overripeness or damage to the fruit increased with passage of time after picking. Loss in value of fruit held only 20 hours prior to grading ranged from $1.50 to $5.00 per ton at the prices used for 1952.

The time required for grading and sorting any given volume of olives could be shortened by decreasing the time loss in the separate-lots system of accounting now being used in the Corning area. In studies of plant operating during the 1952 season, breaks between lots caused a loss of effective working time of from 7.5 to 23.7 per cent of total working time in eight olive plants in the Corning and Oroville areas.

Improvement in the break-for-lots procedure appears possible in all of the plants studied. The range of possible savings in these plants through improvements in procedure which would reduce the break time per lot to an average of two minutes ranged from no saving to a saving of $0.30 per 1,000 pounds of fruit received. Additional savings might be achieved in some plants by consolidating the smaller lots.

The grade of fruit delivered by the grower can be established by a sample grading procedure. Tests of sample graders in the Corning area in 1952 indicate that the machines tested were of adequate mechanical accuracy. Some variation will occur between the distribution of fruit in the sample and in the entire lot of fruit. The probable amount of error resulting from such variation decreases as the per cent of fruit taken in the sample increases.

The sampling costs per ton of fruit increase as the admissible error is reduced. Sampling costs per ton are reduced as the total deliveries per grower per season increase. With an admissible error of 0.5 per cent, it appears that the costs of a sample grading system would be higher than costs with an improved break-for-lots system in all but one of the plants studied. With an admissible error of 1.0 per cent, however, it appears that costs could be lowered in five of the plants studied by shifting to a sample grading system. Compared with an improved break-for-lots system, estimated costs of sample grading range from $0.30 higher per 1,000 pounds of fruit run in the plant least adapted to sample grading to $0.45 lower per 1,000 pounds of fruit run in the plant best adapted to sample grading. Reports from twelve growers in the Corning area indicated an average cost for picking and hauling Sevillano olives of $62 per ton during the 1952 season.

From detailed studies of picking operations, results were obtained which may be used to estimate adjustments in piecework rates of payment for picking as a means of compensating for unusual picking conditions. These studies also showed that, on the average, only 16 per cent of the picker's time was spent in "nonpicking" elements such as moving ladders, climbing, and emptying buckets. This indicates that the use of mechanically operated picking platforms is not likely to prove economical unless a marked improvement in the actual picking operations also is obtained.

Studies of orchard-to-plant transportation indicate a wide range in labor requirements with different methods. For a grower located one mile from the plant, the range was from 33 to 113 man-minutes per 100 boxes. The method having the minimum labor requirement, however, is not necessarily the most economical. Equipment costs in relation to volume hauled per season, and alternative uses for equipment at other seasons, must also be considered.

Total labor and equipment costs for receiving and grading Sevillano olives are given for eight different types of plants, involving various combinations of different equipment and work methods. These estimates indicate that relative costs with the different types of plants depend on the methods and equipment used, the size of plant, and the hours of operation per season. In a plant of average size--10,000 pounds of fruit run per hour--the range in total season costs was from $4,900 to $5,900 with 150 hours of operation per season. This range was from $7,600 to $9,900 per season with 300 hours of operation.

[illegible] as the per cent of fruit taken in the sample increases.

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From detailed studies of picking operations, results were obtained which may be used to estimate adjustments in piecework rates of payment for picking as a means of compensation for unusual picking conditions. These studies also showed that, on the average, only 15 per cent of the picker's time was spent in "noncycle" [illegible] notes that the use of mechanically operated picking platforms is not likely to prove economical unless a marked improvement in the actual picking operation is [illegible].

Studies of orchard-to-plant transportation indicate a wide range in labor requirements with different methods. For a grower located one mile from the plant, the range was from 33 to 143 man-minutes per 100 boxes. The method having the minimum labor requirement, however, is not necessarily the most economical. [illegible] ment costs in relation to volume hauled per season, and alternative uses for equipment [illegible].

Total labor and equipment costs for receiving and grading canning olives are given for eight different types of plants, involving various combinations of [illegible]. These [illegible] costs with the different types of plants depend on the methods and equipment used, the size of plant, and the hours of operation per season. In a plant of average size—14,000 pounds of fruit run per hour—the range in total season costs was from $4,900 to $5,900 with 150 hours of operation per season. This range was $7,500 to $8,300 per season with 300 hours of operation.

APPENDIX A

PROCEDURES IN ESTIMATING PLANT COSTS

In receiving and grading olives, certain operations are performed which are basically alike in all plants. There are important variations, however, in the methods and equipment used in different plants to perform particular operations. To compare the costs and efficiency of these different methods, it is necessary to have costs for operation with each method under standardized conditions which are uniform except for specified variations in equipment or work methods. The "standardized" plants for which such estimates are made in this report are typical of efficient--though not optimum--plants. The resulting cost estimates may differ from those applicable to any particular plant, but they should be representative of efficient levels of operation and should be good indicators of relative costs with different methods.

The operations studied include receiving the incoming fruit, transporting fruit and field boxes within the plant, dumping the fruit at the grading line, collecting size-graded fruit at the grading machine, and moving the graded fruit to storage in the processing tanks. These operations are described, and costs with different methods are compared in the text of this report. In this Appendix, summary data are given on the production and cost rates used in the analysis; the procedures used in the analysis also are indicated.

The cost estimates with different methods are based on standardized production and cost rates derived from studies of actual plant operations. Two cost categories are recognized. These are direct costs, such as labor, electric power, gasoline, and fixed costs for equipment.

Estimating Equipment Costs

The fixed charges for equipment used in the studies of plant costs include taxes, insurance, interest on the investment, "fixed" repair expense, and depreciation. These costs vary widely with such factors as type of equipment, conditions of use, and locality. The appropriate rate for a given piece of equipment, also, is affected by uncertainty as to actual use life and as to future cost rates for such items as taxes and repairs. This means that actual costs for equipment can be determined only at the end of the use period. For the analysis in this report, however, some "forecast" is required of the appropriate level of these costs. For this purpose, the equipment costs are estimated primarily in terms of uniform annual fixed charges.

[illegible]

[illegible]

[illegible] basically alike in all plants. There are important variations, however, in the [illegible] equipment used in different plants to perform particular operations. [illegible] to have costs for operation with each method under standardized conditions which are uniform except for specified variations in equipment or work methods. The "standardized" plants for which such estimates are made in this report are typi- [illegible] differ from those applicable to any particular plant, but they should be representative of efficient levels of operation and should be good indicators of [illegible]

[illegible] fruit and field boxes within the plant, dumping the fruit at the grading line, collecting size-graded fruit at the grading machine, and moving the graded fruit to storage in the processing tanks. These operations are described, and costs with different methods are compared in the text of this report. In this Appendix, [illegible] procedures used in the analysis also are indicated.

The cost estimates with different methods are based on standardized production and cost rates derived from studies of actual plant operations. Two cost categories are recognized. These are direct costs, such as labor, electric power, gasoline, and fixed costs for equipment.

[illegible]

[illegible] ciation. These costs vary widely with such factors as type of equipment, condi- [illegible] also, is affected by uncertainty as to actual use life and as to future cost rates for such items as taxes and repairs. This means that actual costs for equipment can be determined only at the end of the use period. For the analysis [illegible]

The annual fixed costs are computed by applying commonly used cost-accounting percentages to the estimated replacement costs for the equipment. The percentage rates used, excluding depreciation, are: insurance, 1.0 per cent; taxes, 1.0 per cent, "fixed" repair expense, 1.5 per cent; and interest, 3.0 per cent (approximately 5.0 per cent on the undepreciated balance of the investment). In this report, the expected use life of equipment such as fork trucks and pallets is considered to be 10 years, and for equipment such as hand trucks and size graders, 15 years. With depreciation based on a 10-year life, the percentage annual charge is 10.0 and the total percentage annual charge is 16.7; with a 15-year life, the depreciation rate is 6.7 per cent and the total annual charge is 13.2 per cent.

Estimated costs for the major items of equipment used in the plant receiving and grading operations for olives are summarized in Table A. These include estimates of replacement costs for equipment at 1952 prices, the percentage annual charge for each type of equipment, estimated annual fixed costs, and estimated direct repair costs per hour. As very little data on repair expense for different types of equipment are available, these costs can only be approximated, and some arbitrary allocation of repair expense is necessary. In Table A, two components of repair expense are included. One covers repairs that are more or less independent of hours of use. Such costs are included as a "fixed" repair cost per year expressed as a percentage of the replacement cost. The second category includes repairs directly attributable to use, and these expenses are estimated at the rate of 0.5 per cent of the replacement cost per 100 hours of use.

Crew Requirements and Costs for Receiving and Grading Olives

Production Standards

The number of workers required for a given job depends on the required total rate of production in that job and the production rate per worker. On most jobs the work consists of a more or less continuous repetition of some particular operation, such as dumping a box of fruit at the grading line. The normal production rate per worker then depends on the net time required per unit of operation when the job is performed at a normal speed, plus an allowance for scheduled rest periods and unavoidable delay. The unit time requirements and allowances for rest and delay used in this report are based on studies of the various jobs made in a number of plants. The proportion of delay used with a particular job is selected so as to represent full utilization of the worker when the job is performed at a normal rate. The delay proportion thus is applicable to efficient though not necessarily optimum operation.

[illegible] approximately 5.0 per cent on the undepreciated balance of the investment). In this report, the expected use life of equipment such as fork trucks and pallets is considered to be 10 years, and for equipment such as hand trucks and size graders, 15 years. With depreciation based on a 10-year life, the percentage [illegible] year life, the depreciation rate is 6.7 per cent and the total annual charge is [illegible]

Estimated costs for the major items of equipment used in the plant receiving and grading operations for olives are summarized in Table A. These include [illegible] at 1952 prices, the percentage annual charge for each type of equipment, estimated annual fixed costs, and estimated repair costs per hour. As very little data on repair expense for different types of equipment are available, these costs can only be approximated, and some arbitrary allocation of repair expense is necessary. In Table A, two components of repair expense are included. One covers repairs that are more or less independent of hours of use. Such costs are included as a "fixed" repair cost [illegible] at the rate of 0.5 per cent of the replacement cost per 100 hours of use.

[illegible]

Production Standards

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TABLE A

Estimated Costs for Equipment Used in the Receiving and Initial Processing of Olives, Corning Area, 1952

Item	Units	Replacement cost, 1952	Annual fixed cost		Direct repair expense
			Per cent of replacement cost[a]	Annual charge	
		dollars		dollars	dollars per hour
Bin, storage capacity, 6,600 pounds of olives	Each	400	13.2	53	.020
Boxes, field	100 boxes	90	16.5	15	.005
Conveyor for boxes:					
Gravity	8 feet	28	13.2	4	.002
Power 20 feet long	Each	540	13.2	71	.027
100 feet long	Each	1,090	13.2	144	.054
Conveyor for loose fruit:					
12-inch belt, 20 feet long	Each	390	13.2	51	.020
12-inch belt, 100 feet long	Each	860	13.2	114	.043
20-inch belt, 20 feet long	Each	810	13.2	107	.040
20-inch belt, 100 feet long	Each	1,370	13.2	181	.068
Grader (cable type):					
5,000-pounds per hour capacity	Each	4,800	13.2	630	.240
10,000-pounds per hour capacity	Each	8,500	13.2	1,120	.425
Pallets	100 pallets	390	16.5	64	.020
Scale:					
2,000-pound capacity	Each	1,000	13.2	130	--
Skids	100 skids	400	16.5	66	.020
Trucks:					
Fork truck, 4,000-pound capacity	Each	3,700	16.5	610	.185
Handcart	Each	75	13.2	10	.004
Hand pallet truck	Each	600	13.2	79	.030
Hand skid-truck	Each	250	13.2	33	.012
Hand truck (side clamp)	Each	75	13.2	10	.004

[a] Percentage annual charge consists of: insurance, 1.0 per cent; taxes, 1.0 per cent; "fixed" repair expense, 1.5 per cent; interest, 3.0 per cent (approximately 5.0 per cent on undepreciated balance), and depreciation as a percentage of useful life. For equipment such as conveyors and hand trucks, use life is considered to be 15 years; for equipment such fork trucks and pallets, use life is considered to be 10 years.

The procedure may be illustrated with the job of dumping field boxes of fruit at the grading line. The work involves getting a full box from a pallet, emptying the contents into a hopper, and restacking the empty box on an empty-box pallet. In addition, there are miscellaneous operations such as handling empty pallets and disposing of the grower's receipt attached to each lot. From studies of this job in a number of plants, the following data were obtained.

Item		Labor required man-minutes per box
Net time		0.234
Miscellaneous labor, 7.6 per cent of net labor		0.018
Delays as a percentage of total labor:		
Average break-for-lots	6.6 per cent	
Other delays	5.0 per cent	
Scheduled rest periods	4.2 per cent	
Total	15.2 per cent	0.048
Gross labor requirement		0.300

Using the gross unit labor requirements obtained above, the production standard for this job is (60/0.300) = 200 boxes per hour. With an average net weight of 40 pounds per box, this is equivalent to a rate of 8,000 pounds of fruit dumped per hour. While the rate of dumping boxes in a particular plant may differ from this estimate, it represents the typical or "standard" production rate that may be expected on this job under efficient operating conditions. Production standards similarly can be established for other jobs. A summary of such estimates for the jobs involved in the receiving and grading operations is given in Table B. This table contains, for each job, the standard production rate per hour and, where trucking is involved, the average trucking distance per trip.

Typical Wage Rates

Wage rates for a given job varied between plants, although the range was relatively small. Typical rates for the plants studied in the Corning area during the 1952 season are summarized in Table C.

TABLE B

Production Standards for Various Jobs Involved in Receiving and Grading Sevillano Olives, Corning Area, 1952

Job	Per cent[a] delay	Production standard	
		Boxes per hour	Pounds of fruit per hour
Collect graded fruit at size grader:			
Place empty boxes at grader chute, set off full boxes to handcart, move handcart to scale	20	--	4,300
Miscellaneous operations with box system (supply empty boxes, assist weigher, restack weighed boxes on carts)	20	--	12,200
Place empty bins at grader, move bins grader to scale:			
600-pound-capacity bins	64	--	5,200
1,200-pound-capacity bins	64	--	5,200
Dump field boxes into hopper:			
From conveyor	10	490	19,600
From pallet or skid	20	200	8,000
Dump boxes of graded fruit into tanks or vats:			
Dump into low-sided tanks	20	320	11,500
Dump into high-sided vats[b]	20	160[b]	5,200[b]
Nest empty boxes on conveyor from dumper (set off one-half of nested boxes on floor, later return them to conveyor)	20	685	27,400
Set off full field boxes from grower's truck to conveyor	10	490	19,600
Stack full field boxes on skid	20	410	16,400
Stack empty boxes on truck	20	820	32,800
Sorters	[c]	[c]	[c]
Trucking--graded fruit:			
Transport boxes fruit with handcart--load size, 12 boxes; net weight, 36 pounds each (trucking only):			
With 125 feet, 1-way distance per trip	20	--	17,500
With 200 feet, 1-way distance per trip	20	--	12,200
Transport fruit in bins with fork truck and dump bins:			
600-pound-capacity bin:			
With 125 feet, 1-way distance per trip	20	--	14,500
With 200 feet, 1-way distance per trip	20	--	11,300
1,200-pound-capacity bin:			
With 125 feet, 1-way distance per trip	20	--	29,000
With 200 feet, 1-way distance per trip	20	--	22,600
Trucking--incoming fruit--move fruit from grower's truck to temporary storage then to dumper. Move empty boxes from dumper to grower's truck via temporary storage:			
Hand skid-truck--load size, 40 boxes; average 1-way distance per move, 40 feet	20	310	12,400
Hand truck--load size, 7 full boxes; 10 empty boxes; average 1-way distance per trip, 45 feet	20	150	6,000
Fork truck--load size, 40 boxes; average 1-way distance per trip, 60 feet	20	460	18,400
Weigh graded fruit and record weights	--	--	17,000

(Continued on next page.)

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	Job
			Collect graded fruit at size grader;
[illegible]	[illegible]	[illegible]	Place empty boxes at grader chute, set off full boxes to handcart, move handcart to scale
			[illegible]
[illegible]	[illegible]	[illegible]	[illegible], assist weigher, restack weighed boxes on truck)
			[illegible] empty bins at grader, move bins grader to scale:
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]
[illegible]	[illegible]	[illegible]	Dump into low-sided tanks
[illegible]	[illegible]	[illegible]	Dump into high-sided vats
[illegible]	[illegible]	[illegible]	Nest empty boxes on conveyor from dumper (set off one-half of nested boxes on floor, later return them to conveyor)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Stack full field boxes on skid
[illegible]	[illegible]	[illegible]	Stack empty boxes on truck
[illegible]	[illegible]	[illegible]	[illegible]
			[illegible] fruit:
			Transport boxes fruit with handcart--load size, 12 boxes; [illegible] weight, 36 pounds each (transporting only):
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table B continued.

a/ Delay is expressed as a percentage of total work time. In all cases, it includes 4.2 per cent for scheduled rest periods with the remainder representing the "minimum" delay to be expected under efficient operating conditions. An exception is the job of dumping field boxes: on this job the "delay" includes rest, 4.2 per cent; break-for-lots delay, 6.8 per cent; and miscellaneous delay, 5.0 per cent.

b/ Production rate per worker for a 2-man dumping team.

c/ See Table F.

TABLE C

Typical Wage Rates in Receiving and Grading Operations for Sevillano Olives, Corning Areas, 1952

Job category	Wage rate
	dollars per hour
Cartmen	1.25
Binmen	1.25
Dumper	1.25
Set off boxes at grader	1.25
Sorter	1.10
Trucker:	
Hand truck or hand skid-truck	1.25
Fork truck	1.40
Utility man	1.25
Weighman	1.30

Crew Requirements and Costs for Receiving and Dumping Incoming Fruit

Estimates of crew requirements and costs are based on the production standards given in Table B. The procedure can be illustrated with the hand skid-truck method of receiving in which field boxes of fruit are transferred by hand to a skid of 30-to-40-box capacity, and the skid loads of fruit are transported within the plant with a hand skid-truck. The jobs involved and the standard production rates are as follows:

Job	Production standard	
	Boxes per hour	Pounds of fruit per hour
Stack boxes on skids: Grower sets box on receiving dock or on edge of truck; plant receiver stacks box on skid. For work of plant receiver only.[a]	410	16,400
Transfer empty boxes from skid to grower's truck: Procedure similar to stacking incoming boxes. Work of plant receiver only.	820	32,800
Dump field boxes: Lift boxes by hand from skid; empty contents in dumping hopper.	200	8,000
Move skid: Move skid loads of fruit to temporary storage, then to dumper. Similarly, move empty lugs from dumper to grower's truck via temporary storage.	310	12,400

[a] In some instances, the entire stacking operation was performed by the grower, but for purposes of comparison, it is assumed that this operation is performed jointly by the grower and plant receiver except in the very small plants. Only the labor cost of the plant worker is included in the cost estimates.

Using the above production rates, estimates of the labor and equipment requirements and costs can be made for different rates of receiving and dumping. These estimates are worked out on a step-by-step basis by adding an additional worker and equipment unit as the typical production rate of a given crew is reached. In the initial step--with volume per hour very low--some of the jobs are combined. In the estimates for a very small plant, for example, it is assumed that the trucker and dumper jobs are combined and that the box-stacking job is performed entirely by the grower. Combining the production standards given above on this basis results in a production standard for the combined operations of 2,800 pounds of fruit per worker per hour. Similarly, the production rate of a crew consisting of a dumper and a trucker--who also assists the grower in stacking boxes--is 4,500 pounds per hour. At higher rates of operation per hour, the jobs may be still more specialized.

Crew requirements based on the production standards are the basis for the cost estimates. Thus, for rates of operation less than 2,800 pounds per hour, the plant receiving and dumping crew consists of a trucker-dumper, and the equipment for this operation consists of a hand skid-truck and skids.[28] Using the cost rates given in Tables A and C, the direct costs are $1.27 per hour of which $1.25 is for labor and $0.02 is for equipment repair. Annual fixed costs for the hand skid-truck and skids are $55. Similarly, with rates of operation between 2,800 and 4,500 pounds per hour and a plant crew consisting of one trucker and one dumper, the direct costs are $2.52 per hour and the annual fixed costs are $55. By a similar procedure, estimates of direct and fixed costs may be obtained for still higher rates of plant operation.

Estimates of crew requirements and of labor and equipment costs obtained in the above manner are summarized in Table D for six different methods of receiving and dumping incoming fruit. For a given method, each line in this table gives the number of workers required in each labor category for the specified rate of plant operation as well as the corresponding labor and equipment costs. The volume range given with each set of crew requirements and costs represents the upper limit for the crew indicated. With the hand skid-truck method, for example, a crew consisting of a trucker-dumper is adequate for plant volumes less than 2,800 pounds per hour. With plant volumes between 2,800 and 4,500 pounds per hour, a crew consisting of one trucker and one dumper is required and so on for still higher plant volumes.

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[28] The estimated fixed costs include allowance for 30 skids per truck. See Table A for details as to fixed costs.

TABLE D

Crew Requirements and Costs for Receiving and Dumping Sevillano Olives with Different Types of Equipment, Corning Area, 1952

Volume range, 1,000 pounds per hour	Number of workers			Direct cost[a]			Fixed cost	
	Dumper	Trucker	Box stacker[b]	Labor	Equipment, repair, and operation	Total	Replacement cost, 1952	Annual fixed cost[c]
				dollars per hour			dollars	
Method A--Hand Skid-Truck								
2.8	--	1	--	1.25	0.02	1.27	420	55
4.5	1	1	--	2.50	0.02	2.52	420	55
8.0	1	2	--	3.75	0.04	3.79	830	110
9.1	2	2	--	5.00	0.04	5.04	830	110
13.6	2	3	--	6.25	0.06	6.31	1,250	165
16.0	2	4	--	7.50	0.08	7.58	1,670	220
18.2	3	4	--	8.75	0.08	8.83	1,670	220
22.7	3	5	--	10.00	0.10	10.10	2,080	275
Method B--Fork Truck								
5.4	1	1[d]	--	1.80	.14	1.94	910	150
8.0	1	1[e]	1	3.20	.17	3.37	1,180	195
16.0	2	1	1	5.15	.35	5.50	2,270	375
16.4	3	1	1	6.40	.35	6.75	2,270	375
18.4	3	1	2	7.65	.35	8.00	4,180	690
22.9	3	2	2	9.05	.70	9.75	4,300	710
Method C--Fork Truck								
5.4	1	1[d]	--	1.80	.14	1.94	1,150	190
8.0	1	1[e]	--	1.45	.17	2.12	1,320	218
16.0	2	1	--	3.90	0.35	4.25	3,060	505
18.4	3	1	--	5.15	0.35	5.50	3,300	545
22.9	3	2	--	6.55	0.70	7.25	5,520	910
Method D--Hand Truck								
3.4	--	1 --	--	1.25		1.25	80	10
6.0	1	1	--	2.50	0.01	2.51	80	10
8.0	1	2	--	3.75	0.01	3.76	150	20
12.0	2	2	--	5.00	0.01	5.01	150	20
16.0	2	3	--	6.25	0.02	5.27	230	30
18.1	3	3	--	7.50	0.02	7.52	230	30
23.5	3	4	--	8.75	0.02	8.77	305	40
Method F--Set off and four-hour storage								
5.0	1	--	1	2.50	.31	2.81	4,960	620
10.0	1	--	1	2.50	.43	2.93	7,240	950
15.0	1	--	1	2.50	.57	3.07	9,770	1,290
16.8	1	--	1	2.50	.69	3.19	12,100	1,560
19.5	1	--	1	2.50	.76	3.26	13,400	1,770
25.0	2	--	1	3.75	.92	4.67	16,400	2,160
Method E --Set off direct to dumper								
5.0	1	--	1	2.50	.08	2.58	1,280	170
10.0	1	--	1	2.50	.09	2.59	1,500	200
16.8	1	--	1	2.50	.11	2.61	1,870	260
19.5	1	--	1	2.50	.12	2.62	2,100	275
25.0	2	--	1	3.75	.15	3.90	2,250	300

(Continued on next page.)

Table D continued.

a/ For wage rates used in computing labor costs, see Table C. Equipment costs include gasoline and oil for fork trucks at $0.17 per truck per hour, electric power at the rate of $0.03 per motor horsepower per hour, and direct repair costs estimated at 0.5 per cent of replacement cost per 100 hours of use per year.

b/ The box stacker with Method A is included with the truckers; box stacker with Method B stacks full boxes on pallets; box stacker with Methods E and F nests empty boxes on conveyor.

c/ Annual fixed costs estimated as 13.2 per cent of replacement cost for hand trucks and conveyors and 16.5 per cent of replacement cost for fork trucks. Equipment cost for hand skid-trucks includes skids estimated at the rate of 30 skids per 5,000 pound plant capacity per hour; equipment cost for fork trucks includes allowance for field pallets at the rate of 125 pallets per fork truck used in receiving. One-half of fixed costs for fork trucks are allocated to processing operations at other seasons.

d/ Sixty per cent of labor and equipment cost allocated to transporting graded fruit.

e/ Fifty per cent of labor and equipment cost allocated to transporting graded fruit.

In the cost estimates given in Table D for the fork-truck metnods of receiving, the use of the fork truck in the small plants is allocated between the transportation of incoming fruit and graded fruit. Also, one-half of the fixed costs for the fork trucks (but not for pallets) are allocated to processing operations carried on at other seasons.[29]

Crew Requirements and Costs for Handling Graded Fruit

Following the procedures outlined above for the receiving and dumping operations, estimates of crew **requirements** and costs can be developed for the operations required in handling graded fruit between the size grader and the processing tanks. Cost estimates with four different methods are given in Table E. These estimates are based on the production standards for the various jobs given in Table B and on the cost rates for equipment and labor given in Tables A and C.

Crew Requirements and Costs for Sorting and Size Grading

As noted in the text of this report, the labor used to sort out cull fruit, to break up fruit clusters, and in some plants to remove stems varied considerably in different plants. Approximate crew requirements and costs for the sorting operation under average conditions are given in Table F in relation to volume run per hour. This table also gives the estimated equipment costs for the sorting tables and for the size-grading machines. Equipment for these operations usually is "custom built" and, for this reason, the equipment costs are scaled in proportion volume rather than being included in "steps" corresponding to the capacities of particular machines. Labor and equipment costs are computed from the crew requirements indicated in Table F and from the cost rates for labor and equipment given in Tables A and C.

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[29] This is an arbitrary allocation. It is based on the fact that approximately as many movements of fruit and containers are required in the receiving operations as in processing and canning. Although the rate at which fruit is processed and canned in contrast with the rate of receiving and grading would affect the number of equipment units required for each set of operations--and, thereby, would affect the equipment cost allocations--an equal division of fixed costs for the fork truck seems to be the most logical procedure.

TABLE E

Crew Requirements and Costs for Handling Sevillano Olives Between Sizer and Brine Tanks, with Different Types of Equipment, Corning Area, 1952

Volume range 1,000 pounds per hour	Number of workers				Direct cost[a]			Fixed cost[b]	
	Cartmen and dumpers	Fill box at grader	Fill box at grader	Bin-men	Labor	Equipment repair and operation	Total	Replace-ment cost	Annual fixed cost
					dollars per hour			dollars	
Method G. Box Graded Fruit, Handcart to Low-Sided Tanks, Hand Dump in Brine									
3.35	1	1	--		2.50	.01	2.51	230	30
4.30	2	1	--		3.75	.01	3.76	270	35
6.74	2	2	--		5.00	.02	5.02	300	40
8.60	3	2	--		6.25	.02	6.27	300	40
11.43	3	3	--		7.50	.02	7.50	380	50
12.48	4	3	--		8.75	.02	8.77	380	50
12.90	5	3	--		10.00	.03	10.03	450	60
17.20	5	4	--		11.25	.03	11.28	610	80
18.25	5	5	--		12.50	.03	12.53	610	80
21.50	6	5	--		13.75	.03	13.78	680	90
Method H. Box Graded Fruit, Handcart to High-Sided Vats, Hand Dump in Brine									
2.67	2	1	--		3.75	.01	3.76	230	30
4.30	3	1	--		5.00	.01	5.01	270	35
5.25	3	2	--		6.25	.02	6.27	270	35
6.06	5	2	--		8.75	.02	8.77	300	40
8.60	6	2	--		10.00	.02	10.02	300	40
10.50	6	3	--		11.25	.02	11.27	340	45
12.22	8	3	--		13.75	.02	13.77	380	50
12.90	8	4	--		15.00	.02	15.02	420	55
15.75	8	5	--		16.25	.03	16.28	450	60
17.20	10	5	--		18.75	.03	18.78	530	70
18.18	10	6	--		20.00	.03	20.03	610	80
21.00	11	6	--		21.25	.03	21.28	680	90
Method I. Collect Graded Fruit in 600-Pound-Capacity Bins, Transport to Vats or Tanks with Fork Truck									
5.17	1 (60%)		--	1	2.10	.21	2.31	2,330	385
5.41	1 (60%)		--	2	3.35	.21	3.56	2,390	395
7.62	1 (50%)		--	2	3.20	.18	3.38	2,730	450
10.34	1		--	2	3.90	.35	4.25	4,150	685
11.30	1		--	3	5.15	.35	5.50	4,270	705
15.51	2		--	3	6.55	.70	7.25	7,030	1,160
20.68	2		--	4	7.80	.70	8.50	8,060	1,330
Method J. Collect Graded Fruit in 1,200-Pound-Capacity Bins, Transport to Vats or Tanks with Fork Truck									
5.17	1 (50%)		--	1	1.95	.18	2.13	2,120	350
8.00	1 (50%)		--	2	3.20	.18	3.38	2,730	450
10.34	1		--	2	3.90	.35	4.25	4,090	675
15.51	1		--	3	5.15	.35	5.50	5,060	835
20.68	1		--	4	6.40	.35	6.75	6,090	1,005

(Continued on next page.)

Table E continued.

a/ For wage rates used in computing labor costs, see Table C. Equipment operating costs include gasoline and oil for fork trucks at $0.17 per truck per hour, electric power at the rate of $0.03 per motor horsepower per hour, and direct repair costs estimated at 0.5 per cent of replacement cost per 100 hours of use per year.

b/ Annual fixed costs estimated as 13.2 per cent of replacement cost for handcarts and 16.5 per cent of replacement cost for bins and fork trucks. One-half of fixed cost for fork trucks is allocated to processing operations at other seasons.

TABLE F

Average Labor Requirements and Labor and Equipment Costs for Sorting and Size Grading Unprocessed Sevillano Olives, Corning Area, 1952

		Sorting					Size grading		
		Direct costs			Equipment cost		Direct cost	Equipment cost	
Volume of fruit run[a]	Number of sorters	Labor[b]	Power and direct repair[c]	Total	Replacement cost, 1952	Annual fixed cost[d]	Power and direct repair[c]	Replacement cost, 1952	Annual fixed cost
pounds per hour		dollars per hour			dollars		dollars per hour	dollars	
5	4	4.40	.05	4.45	580	77	.25	4,800	635
10	6	6.60	.05	6.65	660	87	.48	8,600	1,135
15	8	8.80	.06	8.86	740	98	.71	12,400	1,635
20	10	11.00	.06	11.06	820	108	.95	16,300	2,150
25	12	13.20	.06	13.26	900	119	1.19	20,200	2,665

a/ Average volume of fruit run per hour of actual operation. In computing this average rate, gross operating time is adjusted so as to delete nonproductive time spent in rest periods and in delays such as break-for-lots.

b/ Based on typical wage rate of $1.10 per hour.

c/ Power cost estimated at $0.03 per motor horsepower per hour; direct repairs estimated as 0.5 per cent of the replacement cost per 100 hours of operation per year.

d/ Estimated as 13.2 per cent of replacement cost.

Crew Requirements for Weighing Graded Fruit and for Superivision

The plant studies indicate that, in plants using the separate-lots system, one weighman can weigh and record the weights of graded fruit for rates of plant operation not exceeding about 17,000 pounds per hour. In some of the small plants, this job was combined with supervision of the receiving and grading operations, but for rates of operation greater than about 7,500 pounds per hour, separate workers were assigned to each job.

Crew Requirements and Costs for All Operations in Receiving and Grading

Using the estimates given above for the various stages of plant operation, it is possible to develop estimates of costs for the entire process of receiving and grading. These costs for a given plant will depend on the combination of

methods used in the various stages of plant operation. As an example, crew requirements and costs are summarized in Table G for a plant in which hand skid-trucks are used in the receiving operations and the handcart method is used to transfer graded fruit to brine storage in high-sided vats. In this table, the crew requirements and labor costs represent a combination of those previously given for the separate stages of the plant operation. The estimates of annual fixed costs for equipment are similarly obtained, and in addition, they include the fixed costs of a floor scale. The annual fixed costs of the building or of the processing equipment are not included, nor are indirect costs such as office clerical expenses and management costs other than direct supervision of the receiving and grading operations.

Estimating Total Season Costs

The data given above can be used to estimate total season costs for particular stages of the plant operation or the entire receiving and grading process. Suppose, for example, that the plant on which Table G is based receives and grades olives at the rate of 10,000 pounds per hour through a 200-hour season. Direct costs for this plant are given in the table as $27.78 per hour, and fixed costs for equipment are $1,430 per season. With 200 hours of operation per season, direct costs then are $5,470, and total costs are $6,990 per season. Similarly, season costs for other rates of operation, for different lengths of season, and for particular stages of the plant operation could be estimated.

Comparison of Costs with Different Methods

The relative costs with different methods can be determined by comparison of the results given in Tables D to G. This can be done most effectively by converting the "step-by-step" cost relationships given in these tables to "smoothed" or "average" cost relationships and by comparing costs in terms of total cost per season so as to take account of the effect of fixed costs for equipment. The procedure may be illustrated by means of the cost data given in Table G for a plant using the hand skid-truck method of receiving and the handcart method of dumping fruit into high-sided vats.

The total season costs with different rates of operation in this plant can be calculated from the direct costs per hour and the annual fixed costs for equipment given in Table G. The results of such calculations for 150 and 300 hours of operation per season are shown in the "step graphs" in Figure A. In these graphs, each step indicates the increase in total costs for a season of given length

TABLE G

Crew Requirements and Cost for the Receiving and Initial Processing of Sevillano Olives, Using Hand Skid-Trucks in the Receiving Operations, and the Handcart Method of Transporting Graded Fruit to High-Sided Vats, Corning Area, 1952

Volume range, 1,000 pounds per hour	Number of workers							Direct cost[a]			Fixed cost	
	Foreman	Weigher	Receiving trucker	Dumper	Sorter	Fill box at grader	Cart and dump	Labor	Equipment repair and operation	Total	Replacement cost	Annual fixed cost[b]
								dollars per hour			dollars	
2.67	1		1		4	1	2	10.90	.24	11.14	4,280	565
2.84	1		1		4	1	3	12.15	.24	12.39	4,470	590
4.30	1		1	1	4	1	3	13.40	.24	13.64	5,950	785
4.54	1		1	1	4	2	3	14.65	.25	14.90	6,100	805
5.00	1		2	1	4	2	3	15.90	.27	16.17	6,480	855
5.25	1		2	1	6	2	3	18.10	.41	18.51	6,700	885
6.06	1		2	1	6	2	5	20.60	.41	21.01	7,350	970
7.50	1		2	1	6	2	6	21.85	.41	22.26	8,480	1,120
7.62	1	1	2	1	6	2	6	23.60	.41	24.01	8,560	1,130
8.60	1	1	2	2	6	2	6	24.85	.41	25.26	9,320	1,230
9.08	1	1	2	2	6	3	6	26.10	.41	26.51	9,730	1,285
10.00	1	1	3	2	6	3	6	27.35	.43	27.38	10,830	1,430
10.50	1	1	3	2	8	3	6	29.55	.67	30.22	11,290	1,490
12.22	1	1	3	2	8	3	8	32.05	.67	32.72	12,690	1,675
12.90	1	1	3	2	8	4	8	33.30	.67	33.97	13,260	1,750
13.62	1	1	3	2	8	5	8	34.55	.68	35.23	13,830	1,825
15.00	1	1	4	2	8	5	8	35.80	.70	36.50	15,300	2,020
15.24	1	1	4	2	10	5	8	38.00	.93	38.93	15,450	2,040
15.75	1	1	4	3	10	5	8	39.25	.93	40.18	15,910	2,100
16.70	1	1	4	3	10	5	10	41.75	.93	42.68	16,740	2,210
17.20	1	2	4	3	10	5	10	43.00	.93	43.93	17,050	2,250
18.16	1	2	4	3	10	6	10	44.25	.93	45.18	17,880	2,360
20.00	1	2	5	3	10	6	11	46.75	.94	47.69	19,810	2,615

[a] Labor costs computed with wage rates given in Table C. Equipment costs include electric power at the rate of $0.03 per motor horsepower per hour and direct repair costs estimated as 0.5 per cent of replacement cost per 100 hours of use.

[b] Annual fixed costs estimated as 13.2 per cent of replacement cost for hand trucks and handcarts.

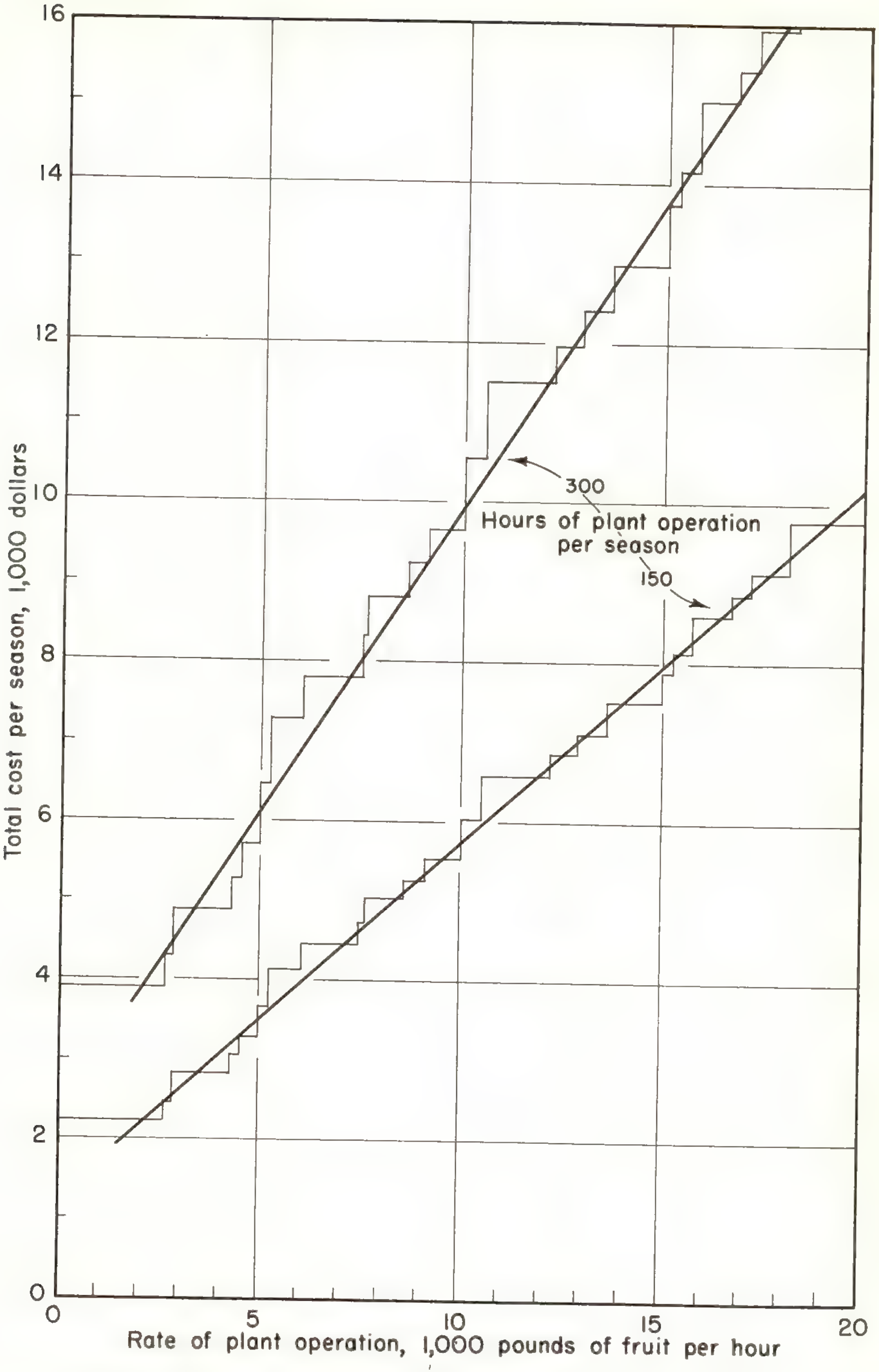

FIGURE A. TOTAL COST PER SEASON FOR RECEIVING AND INITIAL PROCESSING OF SEVILLANO OLIVES IN RELATION TO RATE OF PLANT OPERATION AND HOURS OF PLANT OPERATION PER SEASON -- USING HAND SKID-TRUCK FOR RECEIVING OPERATIONS AND BOXES AND HAND CARTS FOR HANDLING GRADED FRUIT.

corresponding with each addition of crew or equipment. While the step graph represents the costs with the crew organizations specified in Table G, it is likely that, in actual plant operation, crew adjustments would occur over a range of operating rates rather than at the precise points indicated.

If costs in a number of plants of a given size are considered, adjustments of crew size in a particular plant would be expected in the "neighborhood" of the points indicated in Figure A. The average cost situation in these plants then would be at some intermediate point between the high- and low-cost points in each step. Such "average" costs are shown by the uniformly sloping cost lines in Figure A. Using the smoothed line, for example, the total season cost with a volume per hour of 10,000 pounds is $5,700 with 150 hours of operation and $9,900 with 300 hours of operation per season.

In a similar manner, "smoothed" or "average" cost lines can be obtained for other plant designs or for particular stages of the plant operations. Estimates of this type were used in obtaining the costs for particular operations and for the entire receiving and grading process with different types of plants that are given in Tables 16, 17, and 18 in the text of this report.

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